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AERONAUTICAL ENGINEERING

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BIBLIOGRAPHY WITH INDEXES
(SUPPLEMENT 307) (NASA) 118 p

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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES



National Aeronautics and Space Administration
Scientific and Technical Information Program
Washington, DC

1994

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INTRODUCTION

This issue of *Aeronautical Engineering — A Continuing Bibliography with Indexes* (NASA SP-7037) lists 338 reports, journal articles, and other documents recently announced in the NASA STI Database.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)
Open Literature (A-10000 Series)

N94-32420 — N94-34466
None in this issue

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the publication consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals.

Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1994 will be published in early 1995.

Information on availability of documents listed, addresses of organizations, and CASI price schedules are located at the back of this issue.

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TYPICAL REPORT CITATION AND ABSTRACT

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ACCESSION NUMBER → N94-10675*# National Aeronautics and Space Administration. ← CORPORATE SOURCE
Langley Research Center, Hampton, VA.

TITLE → STATIC INTERNAL PERFORMANCE OF A SINGLE
EXPANSION RAMP NOZZLE WITH MULTIAxis THRUST
VECTORING CAPABILITY

AUTHORS → FRANCIS J. CAPONE and ALBERTO W. SCHIRMER (George
Washington Univ., Hampton, VA.) Washington Jul. 1993 ← PUBLICATION DATE
272 p

CONTRACT NUMBER → (Contract RTOP 505-62-30-01)

REPORT NUMBERS → (NASA-TM-4450; L-17163; NAS 1.15:4450) Avail: CASI HCA12/ ← AVAILABILITY AND
MF A03 PRICE CODE

An investigation was conducted at static conditions in order to determine the internal performance characteristics of a multiaxis thrust vectoring single expansion ramp nozzle. Yaw vectoring was achieved by deflecting yaw flaps in the nozzle sidewall into the nozzle exhaust flow. In order to eliminate any physical interference between the variable angle yaw flap deflected into the exhaust flow and the nozzle upper ramp and lower flap which were deflected for pitch vectoring, the downstream corners of both the nozzle ramp and lower flap were cut off to allow for up to 30 deg of yaw vectoring. The effects of nozzle upper ramp and lower flap cutout, yaw flap hinge line location and hinge inclination angle, sidewall containment, geometric pitch vector angle, and geometric yaw vector angle were studied. This investigation was conducted in the static-test facility of the Langley 16-foot Transonic Tunnel at nozzle pressure ratios up to 8.0.

Author (revised)

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 307)

August 1994

01

AERONAUTICS (GENERAL)

N94-32793*# National Aeronautics and Space Administration, Washington, DC.

AIRBORNE TRAILBLAZER: TWO DECADES WITH NASA LANGLEY'S 737 FLYING LABORATORY

LANE E. WALLACE 1994 193 p *Its NASA History series Original contains color illustrations*

(NASA-SP-4216; NAS 1.21:4216; LC-94-5874) Avail: CASI HC A09/MF A03; SOD HC; 76 functional color pages

This book is the story of a very unique aircraft and the contributions it has made to the air transportation industry. NASA's Boeing 737-100 Transport Systems Research Vehicle started life as the prototype for Boeing's 737 series of aircraft. The airplane was acquired by LaRC in 1974 to conduct research into advanced transport aircraft technologies. In the twenty years that followed, the airplane participated in more than twenty different research projects, evolving from a research tool for a specific NASA program into a national airborne research facility. It played a critical role in developing and gaining acceptance for numerous significant transport technologies including 'glass cockpits,' airborne windshear detection systems, data links for air traffic control communications, the microwave landing system, and the satellite-based global positioning system (GPS).

Author (revised)

N94-33016# Federal Aviation Administration, Washington, DC. Office of Aviation Policy and Plans.

FAA AVIATION FORECASTS, FISCAL YEARS 1994-2005

Mar. 1994 194 p

(AD-A277808; FAA-APR-94-1) Avail: CASI HC A09/MF A03

This report contains the Fiscal Years 1994-2005 Federal Aviation Administration (FAA) forecasts of aviation activity at FAA facilities. These include airports with FAA control towers, air route traffic control centers, and flight service stations. Detailed forecasts were made for the major users of the National Aviation System: air carriers, air taxi/commuters, military, and general aviation. The forecasts have been prepared to meet the budget and planning needs of the constituent units of the FAA and to provide information that can be used by state and local authorities, the aviation industry, and the general public. The slow pace of the economic recovery in United States and economic recessions in several of the major world trade areas have caused the aviation industry to experience continued slow traffic growth. However, the outlook for the 12-year forecast period is for moderate economic growth, stable real fuel prices, and modest inflation. Based on these assumptions, aviation activity for fiscal year 2005 is forecast to increase by 22.6 percent at towered airports and 24.0 percent at air route traffic control centers. The general aviation active fleet is forecast to decline by 3.8 percent during the forecast period but increased utilization (hours flown by aircraft) results in a 12.0 percent increase in general aviation hours flown during the same period. Scheduled domestic revenue passenger miles (RPM's) are forecast to increase 55 percent, scheduled international RPMS are forecast to increase by

108 percent, and regional/commuter RPM's are forecast to increase by 166 percent.

DTIC

N94-33046*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

RESEARCH AND TECHNOLOGY, 1993

1993 176 p

(NASA-TM-106376; E-8187; NAS 1.15:106376) Avail: CASI HC A09/MF A02

This report selectively summarizes the NASA Lewis Research Center's research and technology accomplishments for the fiscal year 1993. It comprises approximately 200 short articles submitted by the staff members of the technical directorates. The report is organized into seven major sections: Aeronautics, Aerospace Technology, Space Flight Systems, Space Station, Engineering and Computational Support, Lewis Research Academy, and Technology Transfer and Utilization. A table of contents by subject has been developed to assist the reader in finding articles of special interest. This report is not intended to be a comprehensive summary of all research and technology work done over the past fiscal year. Most of the work is reported in Lewis-published technical reports, journal articles, and presentations prepared by Lewis staff members or by contractors. In addition, university grants have enabled faculty members and graduate students to engage in sponsored research that is reported at technical meetings or in journal articles. For each article in this report a Lewis contact person has been identified, and where possible, reference documents are listed so that additional information can be easily obtained. The diversity of topics attests to the breadth of research and technology being pursued and to the skill mix of the staff that makes it possible.

Author

N94-33064*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

VIBRATION ISOLATION TECHNOLOGY (VIT) ATD PROJECT Final Report

JOSEPH F. LUBOMSKI, CARLOS M. GRODSINSKY, KIRK A. LOGSDON, DOUGLAS A. ROHN, and N. RAMACHANDRAN Mar. 1994 36 p

(Contract RTOP 694-03-0C)

(NASA-TM-106496; E-8487; NAS 1.15:106496) Avail: CASI HC A03/MF A01

A fundamental advantage for performing material processing and fluid physics experiments in an orbital environment is the reduction in gravity driven phenomena. However, experience with manned spacecraft such as the Space Transportation System (STS) has demonstrated a dynamic acceleration environment far from being characterized as a 'microgravity' platform. Vibrations and transient disturbances from crew motions, thruster firings, rotating machinery etc. can have detrimental effects on many proposed microgravity science experiments. These same disturbances are also to be expected on the future space station. The Microgravity Science and Applications Division (MSAD) of the Office of Life and Microgravity Sciences and Applications (OLMSA), NASA Headquarters recognized the need for addressing this fundamental issue. As a result an Advanced Technology Development (ATD) project was initiated in the area of Vibration Isolation Technology (VIT) to develop methodologies for meeting future microgravity science

01 ASTRONAUTICS (GENERAL)

needs. The objective of the Vibration Isolation Technology ATD project was to provide technology for the isolation of microgravity science experiments by developing methods to maintain a predictable, well defined, well characterized, and reproducible low-gravity environment, consistent with the needs of the microgravity science community. Included implicitly in this objective was the goal of advising the science community and hardware developers of the fundamental need to address the importance of maintaining, and how to maintain, a microgravity environment. This document will summarize the accomplishments of the VIT ATD which is now completed. There were three specific thrusts involved in the ATD effort. An analytical effort was performed at the Marshall Space Flight Center to define the sensitivity of selected experiments to residual and dynamic accelerations. This effort was redirected about half way through the ATD focusing specifically on the sensitivity of protein crystals to a realistic orbital environment. The other two thrusts of the ATD were performed at the Lewis Research Center. The first was to develop technology in the area of reactionless mechanisms and robotics to support the eventual development of robotics for servicing microgravity science experiments. This activity was completed in 1990. The second was to develop vibration isolation and damping technology providing protection for sensitive science experiments. In conjunction with the this activity, two workshops were held. The results of these were summarized and are included in this report. Author

N94-33338 Alberta Research Council, Edmonton. Dept. of Advanced Computing Engineering.

THE CF-18 DIAGNOSTIC AND MAINTENANCE EXPERT SYSTEM PROJECT

J. B. TUBMAN, M. D. BRINSMEAD, C. C. LUMB, M. M. MENDOZA, and I. S. L. TAN in Royal Military Coll. of Canada, Proceedings of the Symposium/Workshop on Applications of Expert Systems in DND p 74-92 Apr. 1992

Avail: Issuing Activity (Royal Military Coll. of Canada, Vimy Post Office, Kingston, ON K7K 5L0 Canada)

A feasibility study is being conducted to investigate the appropriateness and practicality of applying expert system technologies to the maintenance of CF-18 aircraft. The target application is two radar test sets, designated AN/USM-469, for testing and fault isolating replaceable subassemblies of the CF-18 AN/APG-65 radar. There are 72 different subassemblies that can be connected to the test sets, and the study concentrated on the radar transmitter as the unit under test. The test program for the radar transmitter contains a sequence of at least 160 test procedures partitioned into 14 groups, the first eight of which must be performed in a given sequence and the last six may be reordered according to the procedure most likely to find a reported fault. The purpose of the expert system would be to assist technicians in making this sequencing decision. The approach taken to accomplish this task is described with reference to the general and special resequencing problems, design and implementation of the test system database, and field testing. It was concluded that the expert system approach is not likely to yield a significant speedup in maintenance time for radar transmitters. The approach was impeded by the need to rerun unneeded safety tests many times if a lot of resequencing takes place. Author (CISTI)

N94-33572* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NACA FIRE CRASH RESEARCH (Videotape)

1992 Videotape: 39 min. playing time, in color, with sound (NASA-TM-109794; NONP-VT-94-12922) Avail: CASI VHS A01/BETA A22

This video provides a better understanding of the important factors involved in the start and spread of crash fires, as a necessary first step leading to significant reduction in the crash fire hazards. CASI

N94-33590 Knowledge Systems, Inc., Atlanta, GA.

COMPOSITE REPAIRS OF CRACKED METALLIC AIRFRAME STRUCTURES Final Report

S. N. ATLURI, J. H. PARK, E. F. PUNCH, P. E. O'DONOGHUE, and RHYS JONES May 1993 188 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract DTRS57-89-C-0008)

(AD-A277680; DOT/FAA/CT-92/32) Avail: CASI HC A09

This report summarizes work that quantifies the benefits of composite patch repairs on cracked metallic aircraft structures. The first chapter describes a data base on bonding methods and repair materials that can be used in design and analysis. In the second chapter, analytical models are derived for the stress intensity factor of cracks in metallic sheets with bonded orthotropic repairs. Specific configurations included through-the-thickness center cracks, through-the-thickness cracks at a loaded fastener hole, surface cracks, and surface cracks at a hole. These analyses can be used in calculations of crack growth life extension resulting from the bonded repairs. Four types of specimens were tested in fatigue to verify the increase in fatigue life. The four configurations were edge crack specimens, surface specimens with multiple site damage (MSD). DTIC

N94-33942* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A DIRECT APPLICATION OF THE NON-LINEAR INVERSE TRANSFORMATION FLIGHT CONTROL SYSTEM DESIGN ON A STOVL AIRCRAFT

W. W. CHUNG, W. E. MCNEILL, and M. W. STORTZ May 1993 28 p

(Contract RTOP 533-02-37)

(NASA-TM-108808; A-94044; NAS 1.15:108808) Avail: CASI HC A03/MF A01

The nonlinear inverse transformation flight control system design method is applied to the Lockheed Ft. Worth Company's E-7D short takeoff and vertical land (STOVL) supersonic fighter/attack aircraft design with a modified General Electric F110 engine which has augmented propulsive lift capability. The system is fully augmented to provide flight path control and velocity control, and rate command attitude hold for angular axes during the transition and hover operations. In cruise mode, the flight control system is configured to provide direct thrust command, rate command attitude hold for pitch and roll axes, and sideslip command with turn coordination. A control selector based on the nonlinear inverse transformation method is designed specifically to be compatible with the propulsion system's physical configuration which has a two dimensional convergent-divergent aft nozzle, a vectorable ventral nozzle, and a thrust augmented ejector. The nonlinear inverse transformation is used to determine the propulsive forces and nozzle deflections, which in combination with the aerodynamic forces and moments (including propulsive induced contributions), and gravitational force, are required to achieve the longitudinal and vertical acceleration commands. The longitudinal control axes are fully decoupled within the propulsion system's performance envelope. A piloted motion-base flight simulation was conducted on the Vertical Motion Simulator (VMS) at NASA Ames Research Center to examine the handling qualities of this design. Based on results of the simulation, refinements to the control system have been made and will also be covered in the report. Author (revised)

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

N94-32475* Illinois Univ., Urbana, IL.

AN EXPERIMENTAL STUDY OF THE FLOWFIELD ON A SEMISPAN RECTANGULAR WING WITH A SIMULATED GLAZE

ICE ACCRETION Ph.D. Thesis, 1993 Final Report

ABDOLLAH KHODADOUST Cleveland, OH NASA Apr. 1994 249 p Original contains color illustrations (Contract NAG3-1134; RTOP 505-68-10) (NASA-CR-195301; E-8693; NAS 1.26:195301) Avail: CASI HC A11/MF A03; 7 functional color pages

Wind tunnel experiments were conducted in order to study the effect of a simulated glaze ice accretion on the flowfield of a semispan, reflection-plane, rectangular wing at $Re = 1.5$ million and $M = 0.12$. A laser Doppler velocimeter was used to map the flowfield on the upper surface of the model in both the clean and iced configurations at $\alpha = 0, 4$, and 8 degrees angle of attack. At low angles of attack, the massive separation bubble aft of the leading edge ice horn was found to behave in a manner similar to laminar separation bubbles. At $\alpha = 0$ and 4 degrees, the locations of transition and reattachment, as deduced from momentum thickness distributions, were found to be in good agreement with transition and reattachment locations in laminar separation bubbles. These values at $y/b = 0.470$, the centerline measurement location, matched well with data obtained on a similar but two dimensional model. The measured velocity profiles on the iced wing compared reasonably with the predicted profiles from Navier-Stokes computations. The iced-induced separation bubble was also found to have features similar to the recirculating region aft of rearward-facing steps. At $\alpha = 0$ degrees and 4 degrees, reverse flow magnitudes and turbulence intensity levels were typical of those found in the recirculating region aft of rearward-facing steps. The calculated separation streamline aft of the ice horn at $\alpha = 4$ degrees, $y/b = 0.470$ coincided with the locus of the maximum Reynolds normal stress. The maximum Reynolds normal stress peaked at two locations along the separation streamline. The location of the first peak-value coincided with the transition location, as deduced from the momentum thickness distributions. The location of the second peak was just upstream of reattachment, in good agreement with measurements of flows over similar obstacles. The intermittency factor in the vicinity of reattachment at $\alpha = 4$ degrees, $y/b = 0.470$, revealed the time-dependent nature of the reattachment process. The size and extent of the separation bubble were found to be a function of angle of attack and the spanwise location. Three dimensional effects were found to be strongest at $\alpha = 8$ degrees. The calculated separation and stagnation streamlines were found to vary little with spanwise location at $\alpha = 0$ degrees. The calculated separation streamlines at $\alpha = 4$ degrees revealed that the bubble was largest near the centerline measurement plane, whereas the tip-induced vortex flow and the model root-tunnel wall boundary-layer interaction reduced the size of the bubble. These effects were found to be most dramatic at $\alpha = 8$ degrees.

Author (revised)

N94-32476*# Analytical Methods, Inc., Redmond, WA.**A NOVEL POTENTIAL/VISCOUS FLOW COUPLING TECHNIQUE FOR COMPUTING HELICOPTER FLOW FIELDS Final Report, 16 Mar. 1990 - 26 May 1993**

J. MICHAEL SUMMA, DANIEL J. STRASH, and SUNGYUL YOO 21 Jun. 1993 89 p (Contract NAS2-13194; SBIR-02.09-9090) (NASA-CR-193272; NAS 1.26:193272; AMI-9304) Avail: CASI HC A05/MF A01

The primary objective of this work was to demonstrate the feasibility of a new potential/viscous flow coupling procedure for reducing computational effort while maintaining solution accuracy. This closed-loop, overlapped velocity-coupling concept has been developed in a new two-dimensional code, ZAP2D (Zonal Aerodynamics Program - 2D), a three-dimensional code for wing analysis, ZAP3D (Zonal Aerodynamics Program - 3D), and a three-dimensional code for isolated helicopter rotors in hover, ZAPR3D (Zonal Aerodynamics Program for Rotors - 3D). Comparisons with large domain ARC3D solutions and with experimental data for a NACA 0012 airfoil have shown that the required domain size can be reduced to a few tenths of a percent chord for the low Mach and low angle of attack cases and to less than 2-5 chords for the high Mach and high angle of attack cases while maintaining solution accuracies

to within a few percent. This represents CPU time reductions by a factor of 2-4 compared with ARC2D. The current ZAP3D calculation for a rectangular plan-form wing of aspect ratio 5 with an outer domain radius of about 1.2 chords represents a speed-up in CPU time over the ARC3D large domain calculation by about a factor of 2.5 while maintaining solution accuracies to within a few percent. A ZAPR3D simulation for a two-bladed rotor in hover with a reduced grid domain of about two chord lengths was able to capture the wake effects and compared accurately with the experimental pressure data. Further development is required in order to substantiate the promise of computational improvements due to the ZAPR3D coupling concept.

Author

N94-32491 Waterloo Univ. (Ontario).**AERODYNAMIC DRAG OF DROPLETS IN TURBULENT FLOW FIELDS Ph.D. Thesis**

WILLIAM DAVID WARNICA 1992 166 p (ISBN-0-315-75827-9) Avail: Univ. Microfilms Order No. DANN75827

The primary objectives of this research were to design, construct, and test an experimental apparatus which introduces liquid droplets into co-flowing, turbulent, gaseous fields under controlled and measurable conditions and to measure the drag of nonevaporating droplets in turbulent flow fields and parametric ranges relevant to spray combustion, as characterized by the Reynolds number, and the intensity and spatial scales of turbulence. Measured drag coefficients are required for use in computational models of equipment such as gas-turbine combustion chambers where flame characteristics and combustion performance are strongly dependent on the manner in which droplets are transported and evaporated. Current computational models use drag coefficients of solid spheres in a quiescent field because the effects of turbulence on drag are not well defined, especially at Reynolds numbers characteristic of spray combustion. The experimental apparatus comprised a wind tunnel and a unique piezoelectric droplet generator. The experimental procedure was to inject water droplets of uniform size co-currently and continuously with vertical turbulent air flows while droplet velocities were measured at different elevations using laser Doppler velocimetry. Turbulence was characterized using hot-wire anemometry prior to droplet injection. Drag coefficients were calculated using these main measurements and the law of conservation of mechanical energy. This experimental methodology provided an effective means of determining the drag of droplets. There was no experimental evidence that the drag of droplets in turbulent fields is significantly different than that of solid spheres in a quiescent field at the same Reynolds number. The total measurement uncertainty of this result was approximately 30 percent. Reynolds numbers were investigated in the range 10 to 100, in terms of the equivalent spherical diameter of a droplet, and the mean relative velocity between the ambient gaseous field and droplets. Weber numbers were much less than unity so that droplets were effectively spherical. Relative intensities of turbulence were investigated in the range 0 to 100 percent, in terms of the mean relative velocity. Spatial scales of turbulence were large in comparison to the droplets so that the ratio between the spatial integral scale and droplet diameter was in the range 4 to 20.

Dissert. Abstr.

N94-32714 Cincinnati Univ., OH.**STUDY OF DYNAMIC STALL PHENOMENON AND ITS CONTROL USING VORTICITY, STREAM FUNCTION AND CIRCULATION FORM OF THE UNSTEADY NAVIER-STOKES EQUATIONS Ph.D. Thesis**

JUNHO YANG 1993 156 p Avail: Univ. Microfilms Order No. DA9319276

An unsteady Navier-Stokes (NS) analysis is developed for studying flow past a maneuvering body. The present inclusion of circulation in the vorticity-stream function formulation of the unsteady NS analysis makes it feasible, for the first time, to correctly simulate the asymptotic far-field boundary condition. In the overall analysis, a clustered conformal mesh with C-grid topology is used, with the governing differential equations being solved using the implicit ADI-BGE technique. The effects of grid size and clustering

on the flow solution, and the effect of grid stretching on the far-field solution, are studied using the flow configuration with $Re = 45,000$ and constant-rate pitch-up motion, with $\dot{\alpha}(\exp +) = 0.2$. The influence of the various initial states considered on this flow field is also carefully examined. The results obtained for this case compare very satisfactorily with the available experimental data. Other numerical results are also used to carefully validate the analysis developed here. An active control strategy in terms of modulated suction/injection (MSI) applied at the airfoil surface and its effect on the aerodynamic forces are studied and extended to various $\dot{\alpha}(\exp +)$ motions, and, to some extent, different Re flows. Finally, an MSI control law for a constant-rate pitch-up motion is developed. The results obtained using this control law provide very optimal control of the unsteady separation process and subsequent formation of the dynamic-stall vortex and leads to an increase in lift and reduction in drag. Dissert. Abstr.

N94-32865* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A FINITE-DIFFERENCE APPROXIMATE-FACTORIZATION ALGORITHM FOR SOLUTION OF THE UNSTEADY TRANSONIC SMALL-DISTURBANCE EQUATION

JOHN T. BATINA Jan. 1992 38 p

(Contract RTOP 505-63-50-12)

(NASA-TP-3129; L-16781; NAS 1.60:3129) Avail: CASI HC A03/MF A01

A time-accurate approximate-factorization (AF) algorithm is described for solution of the three-dimensional unsteady transonic small-disturbance equation. The AF algorithm consists of a time-linearization procedure coupled with a subiteration technique. The algorithm is the basis for the Computational Aeroelasticity Program-Transonic Small Disturbance (CAP-TSD) computer code, which was developed for the analysis of unsteady aerodynamics and aeroelasticity of realistic aircraft configurations. The paper describes details on the governing flow equations and boundary conditions, with an emphasis on documenting the finite-difference formulas of the AF algorithm. Author

N94-32873* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

USER'S GUIDE FOR A FLAT WAKE ROTOR INFLOW/WAKE VELOCITY PREDICTION CODE, DOWN

JOHN C. WILSON Nov. 1991 28 p

(Contract RTOP 505-59-36-01)

(NASA-TM-104139; NAS 1.15:104139; AVSCOM-TR-91-B-016; AD-B161021L) Avail: CASI HC A03/MF A01

A computer code named DOWN was created to implement a flat wake theory for the calculation of rotor inflow and wake velocities. A brief description of the code methodology and instructions for its use are given. The code will be available from NASA's Computer Software Management and Information Center (COSMIC). Author

N94-32880* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

FLIGHT TEST RESULTS OF RIBLETS AT SUPERSONIC SPEEDS

FANNY A. ZUNIGA, BIANCA T. ANDERSON, and ARILD BERTELROD Jun. 1992 37 p

(Contract RTOP 505-60-21)

(NASA-TM-4387; H-1774; NAS 1.15:4387) Avail: CASI HC A03/MF A01

A flight experiment to test and evaluate the skin friction drag characteristics of a riblet surface in turbulent flow at supersonic speeds was conducted at NASA Dryden. Riblets of groove sizes 0.0030 and 0.0013 in. were mounted on the F-104G flight test fixture. The test surfaces were surveyed with boundary layer rakes and pressure orifices to examine the boundary layer profiles and pressure distributions of the flow. Skin friction reductions caused by the riblet surface were reported based on measured differences of momentum thickness between the smooth and riblet surfaces

obtained from the boundary layer data. Flight test results for the 0.0030 in. riblet show skin friction reductions of 4 to 8 % for Mach numbers ranging from 1.2 to 1.6 and Reynolds numbers ranging from 2 to 3.4 million per unit foot. The results from the 0.0013 in. riblets show skin friction reductions of 4 to 15 % for Mach 1.2 to 1.4 and Reynolds numbers ranging from 3.6 to 6 million per unit foot.

Author

N94-32926* Sverdrup Technology, Inc., Brook Park, OH.

AN ANALYSIS OF SUPERSONIC FLOWS WITH LOW-REYNOLDS NUMBER COMPRESSIBLE TWO-EQUATION TURBULENCE MODELS USING LU FINITE VOLUME IMPLICIT NUMERICAL TECHNIQUES Final Report

J. LEE Apr. 1994 15 p Presented at the 32nd Aerospace Sciences Meeting and Exhibit, Reno, NV, 10-13 Jan. 1994; sponsored by AIAA

(Contract NAS3-25266; RTOP 505-62-40)

(NASA-CR-195302; E-8701; NAS 1.26:195302; AIAA PAPER 94-0193) Avail: CASI HC A03/MF A01

A generalized flow solver using an implicit Lower-upper (LU) diagonal decomposition based numerical technique has been coupled with three low-Reynolds number kappa-epsilon models for analysis of problems with engineering applications. The feasibility of using the LU technique to obtain efficient solutions to supersonic problems using the kappa-epsilon model has been demonstrated. The flow solver is then used to explore limitations and convergence characteristics of several popular two equation turbulence models. Several changes to the LU solver have been made to improve the efficiency of turbulent flow predictions. In general, the low-Reynolds number kappa-epsilon models are easier to implement than the models with wall-functions, but require much finer near-wall grid to accurately resolve the physics. The three kappa-epsilon models use different approaches to characterize the near wall regions of the flow. Therefore, the limitations imposed by the near wall characteristics have been carefully resolved. The convergence characteristics of a particular model using a given numerical technique are also an important, but most often overlooked, aspect of turbulence model predictions. It is found that some convergence characteristics could be sacrificed for more accurate near-wall prediction. However, even this gain in accuracy is not sufficient to model the effects of an external pressure gradient imposed by a shock-wave/ boundary-layer interaction. Additional work on turbulence models, especially for compressibility, is required since the solutions obtained with base line turbulence are in only reasonable agreement with the experimental data for the viscous interaction problems. Author

N94-32950* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FOURTH-ORDER 2N-STORAGE RUNGE-KUTTA SCHEMES

MARK H. CARPENTER and CHRISTOPHER A. KENNEDY Jun. 1994 26 p

(Contract RTOP 505-70-62-13)

(NASA-TM-109112; NAS 1.15:109112) Avail: CASI HC A03/MF A01

A family of five-stage fourth-order Runge-Kutta schemes is derived; these schemes required only two storage locations. A particular scheme is identified that has desirable efficiency characteristics for hyperbolic and parabolic initial (boundary) value problems. This scheme is competitive with the classical fourth-order method (high-storage) and is considerably more efficient and accurate than existing third-order low-storage schemes. Author

N94-32974 Department of the Navy, Washington, DC.

ACTIVE VORTEX CONTROL FOR A HIGH PERFORMANCE WING Patent

MARVIN M. WALTERS, inventor (to Navy) and STEVEN B. KERN, inventor (to Navy) 1 Feb. 1994 12 p Filed 21 Dec. 1992

(AD-D016140; US-PATENT-5,282,591; US-PATENT-APPL-SN-994229; US-PATENT-CLASS-244-199) Avail: US Patent and Trademark Office

An on-demand wing vortex control system includes a pair of retractable panels which extend forward through slots in the leading edges of the strake and main wing at their junction. When not in use, the device is retracted in a stowed position, thus having zero impact on the cruise efficiency and observability characteristics designed into the aircraft. The panels extend forward from the strake and wing, providing an added leading edge airfoil surface when in the deployed position. Both panels are slideably and rotatably affixed to the aircraft. A front panel is affixed to and supported within the strake, while a rear panel is affixed and supported within the main wing. The planform of each panel is symmetrically identical, and the movements of the panels are mechanically coordinated. DTIC

N94-32984* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

USE OF NAVIER-STOKES METHODS FOR THE CALCULATION OF HIGH-SPEED NOZZLE FLOW FIELDS

NICHOLAS J. GEORGIADIS and DENNIS A. YODER Jun. 1994 20 p Proposed for presentation at the 30th Joint Propulsion Conference, Indianapolis, IN, 27-29 Jun. 1994; sponsored by AIAA, ASME, SAE, and ASEE (Contract RTOP 537-02-23) (NASA-TM-106551; E-8703; NAS 1.15:106551; AIAA PAPER 94-3212) Avail: CASI HC A03/MF A01

Flows through three reference nozzles have been calculated to determine the capabilities and limitations of the widely used Navier-Stokes solver, PARC. The nozzles examined have similar dominant flow characteristics as those considered for supersonic transport programs. Flows from an inverted velocity profile (IVP) nozzle, an under expanded nozzle, and an ejector nozzle were examined. PARC calculations were obtained with its standard algebraic turbulence model, Thomas, and the two-equation turbulence model, Chien k-epsilon. The Thomas model was run with the default coefficient of mixing set at both 0.09 and a larger value of 0.13 to improve the mixing prediction. Calculations using the default value substantially underpredicted the mixing for all three flows. The calculations obtained with the higher mixing coefficient better predicted mixing in the IVP and underexpanded nozzle flows but adversely affected PARC's convergence characteristics for the IVP nozzle case. The ejector nozzle case did not converge with the Thomas model and the higher mixing coefficient. The Chien k-epsilon results were in better agreement with the experimental data overall than were those of the Thomas run with the default mixing coefficient, but the default boundary conditions for k and epsilon underestimated the levels of mixing near the nozzle exits. Author (revised)

N94-33071* Old Dominion Univ., Norfolk, VA. **CONTROL OF LOW-SPEED TURBULENT SEPARATED FLOW OVER A BACKWARD-FACING RAMP** Ph.D. Thesis - Old Dominion Univ.

JOHN C. LIN May 1992 204 p (NASA-TM-109740; NAS 1.15:109740) Avail: CASI HC A10/MF A03

The relative performance and flow phenomena associated with several devices for controlling turbulent separated flow were investigated at low speeds. Relative performance of the devices was examined for flow over a curved, backward-facing ramp in a wind tunnel, and the flow phenomena were examined in a water tunnel using dye-flow visualization. Surface static pressure measurements and oil-flow visualization results from the wind tunnel tests indicated that transverse grooves, longitudinal grooves, submerged vortex generators, vortex generator jets (VGJ's), Viets' fluidic flappers, elongated arches at positive angle of attack, and large-eddy breakup devices (LEBU's) at positive angle of attack placed near the baseline separation location reduce flow separation and increase pressure recovery. Spanwise cylinders reduce flow separation but decrease pressure recovery downstream. Riblets, passive porous surfaces, swept grooves, Helmholtz resonators, and arches and LEBU's with angle of attack less than or = 0 degrees had no significant effect in reducing the extent of the separation region. Wall-cooling computa-

tions indicated that separation delay on a partially-cooled ramp is nearly the same as on a fully-cooled ramp, while minimizing the frictional drag increase associated with the wall cooling process. Dry-flow visualization tests in the water tunnel indicated that wishbone vortex generators in the forward orientation shed horseshoe vortices; wishbone vortex generators oriented in the reverse direction and doublet vortex generators shed streamwise counterrotating vortices; a spanwise cylinder located near the wall and LEBU's at angle of attack = -10 degrees produced eddies or transverse vortices which rotated with the same sign as the mean vorticity in a turbulent boundary layer; and the most effective VGJ's produced streamwise co-rotating vortices. Comparative wind-tunnel test results indicated that transferring momentum from the outer region of a turbulent boundary layer through the action of embedded streamwise vortices is more effective than by transverse vortices for the separation control application studied herein. Author

N94-33108# Naval Postgraduate School, Monterey, CA. **THE ANALYSIS OF WAKE-INDUCED UNSTEADY AERODYNAMICS RELATED TO HIGHER HARMONIC CONTROL** Ph.D. Thesis

AHMED A. ABOURAHMA Dec. 1993 165 p (AD-A277914) Avail: CASI HC A08/MF A02

Performance data from the NASA-Army OH-6A higher harmonic control (HHC) flight test program showed significant reductions in main rotor shaft torque and engine power in hover and forward flight 1. The unsteady aerodynamics with the higher harmonic control system application, including wake effects, were considered to study whether such power reductions are feasible. An airfoil oscillating in pure plunge can achieve propulsive force (Katzmayr effect), as in the case of birds' wings flapping in flight. Here it will be shown that this effect can be enhanced in the presence of layers of shed vorticity with the proper phasing. In addition, while it is known that an airfoil oscillating in pitch, will typically produce drag at most values of reduced frequency, it is found that the presence of another layer of shed vorticity of the proper phase, can reduce the drag on the pitching airfoil depending upon wake spacing reduced frequency, and phase. Under some conditions the added layer or layers of shed vorticity will even result in propulsive force acting on the pitching airfoil similar to the Katzmayr effect for the plunging case. It was found, for the OH-6A helicopter, that the measured reductions in main rotor shaft torque and engine power are feasible when evaluated with respect to the Katzmayr effect and the additional drag reduction or propulsive force obtained due to pitch and plunge oscillations with the effect of adjacent wake layers of shed vorticity. DTIC

N94-33119* Sverdrup Technology, Inc., Brook Park, OH. **INSTALLED F/A-18 INLET FLOW CALCULATIONS AT 30 DEGREES ANGLE-OF-ATTACK: A COMPARATIVE STUDY** Final Report

C. FREDERIC SMITH and STEVE D. PODLESKI Cleveland, OH NASA Apr. 1994 51 p (Contract NAS3-25266; RTOP 505-68-30) (NASA-CR-195297; E-8678; NAS 1.26:195297) Avail: CASI HC A04/MF A01

NASA Lewis is currently engaged in a research effort as a team member of the High Alpha Technology Program (HATP) within NASA. This program utilizes a specially equipped F/A-18, the High Alpha Research Vehicle (HARV), in an ambitious effort to improve the maneuverability of high-performance military aircraft at low subsonic speed, high angle of attack conditions. The overall objective of the Lewis effort is to develop inlet technology that will ensure efficient airflow delivery to the engine during these maneuvers. One part of the Lewis approach utilizes computational fluid dynamics codes to predict the installed performance of inlets for these highly maneuverable aircraft. Full Navier-Stokes (FNS) calculations on the installed F/A-18 inlet at 30 degrees angle of attack, 0 degrees yaw, and a freestream Mach number of 0.2 have been obtained in this study using an algebraic turbulence model with two grids (original and revised). Results obtained with the original grid were used to

determine where further grid refinements and additional geometry were needed. In order to account properly for the external effects, the forebody, leading edge extension (LEX), ramp, and wing were included with inlet geometry. In the original grid, the diverter, LEX slot, and leading edge flap were not included due to insufficient geometry definition, but were included in a revised grid. In addition, a thin-layer Navier-Stokes (TLNS) code is used with the revised grid and the numerical results are compared to those obtained with the FNS code. The TLNS code was used to evaluate the effects on the solution using a code with more recent CFD developments such as upwinding with TVD schemes versus central differencing with artificial dissipation. The calculations are compared to a limited amount of available experimental data. The predicted forebody/fuselage surface static pressures compared well with data of all solutions. The predicted trajectory of the vortex generated under the LEX was different for each solution. These discrepancies are attributed to differences in the grid resolution and turbulence modeling. All solutions predict that this vortex is ingested by the inlet. The predicted inlet total pressure recoveries are lower than data and the distortions are higher than data. The results obtained with the revised grid were significantly improved from the original grid results. The original grid results indicated the ingested vortex migrated to the engine face and caused additional distortions to those already present due to secondary flow development. The revised grid results indicate that the ingested vortex is dissipated along the inlet duct inboard wall. The TLNS results indicate the flow at the engine face was much more distorted than the FNS results and is attributed to the pole boundary condition introducing numerical distortions into the flow field.

Author (revised)

N94-33263 Naval Surface Warfare Center, Dahlgren, VA.
A NEW METHOD FOR CALCULATING WING ALONG AERODYNAMICS TO ANGLE OF ATTACK 180 DEG
 ROY M. MCINVILLE and FRANK G. MOORE Mar. 1994 65 p
 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
 (AD-A277965; NSWCDD/TR-94/3) Avail: CASI HC A04

A new semiempirical method has been developed to estimate wing alone aerodynamics at all Mach numbers and angles of attack (AOA) encountered in flight. The method utilizes the slender body or linearized theories at low AOA and several wing alone data bases at higher AOA. In areas where data is not available, extrapolations and interpolations are used with existing data. The new method is shown to be more accurate than the second-order technique developed for the 1993 version of the NSWCDD Aeroprediction Code (AP93) over the AOA range of 0 to 30 degrees where that technique is applicable. More importantly, however, is the fact that the new method allows AOA to 180 deg. As a result, this new wing alone method forms the first step in expanding the AP93 to higher AOA than 30 degrees.

DTIC

N94-33382 Colorado Univ., Boulder, CO.
SIMILARITY IN SEPARATED FLOW FIELDS PRODUCING LARGE-SCALE VORTICES Ph.D. Thesis
 ERIC JOE STEPHEN 1992 163 p
 Avail: Univ. Microfilms Order No. DA9318136

Over the last few decades dynamic stall has been the subject of numerous investigations. The increased transient lift produced by unsteady separated flows suggested the potential for enhanced aerodynamic performance. Ultimately a thorough understanding of these flows will lead to important advancements in the design of highly maneuverable aircraft. Recently McLaughlin, in distilling the data from a wide range of dynamic stall cases, demonstrated that the maximum lift is produced coincident with leading edge vortex production. Understanding vortex development is crucial to the exploitation of unsteady aerodynamics. In order to investigate the genesis of large scale vortex development, a few representative flow conditions were selected for analysis: flow over a cylinder, flow over a pitching airfoil, flow over an autorotating plate, and flow over a delta wing. From collected pressure and wake data, a vortex model was

developed that predicts the unsteady vortex behavior across all of these test conditions. In many instances new experimental data were collected to provide sufficient information for model development. In the process of the experiments, a new technique of acquiring pressure data on a rotating body was developed. Also the presence of nonzero stable roll positions for a static delta wing were reported. The pressure data suggest that the vorticity distribution, magnitude, and location can be estimated from the vorticity diffusion rates scaled to the pressure gradients. The characteristic scale of the wake, bounding the accumulated vorticity, provides an estimate of the diameter of large scale vortices. Through a combination of these parameters, a predictive model could be derived for vortex shedding, initiation, and convection. These simple vortex models lead to predictive algorithms for unsteady flow structures. The temporal limits, provided by the model, agree with having temporal characteristics of unsteady vortical flow derived by McLaughlin from all existing empirical data. Since both the analytical and empirical models provide simple linear prediction of unsteady flow behavior, the task of incorporating unsteady aerodynamic designs in new generation aircraft may be simplified.

Dissert. Abstr.

N94-33447* National Aeronautics and Space Administration.
 Langley Research Center, Hampton, VA.

FIRST ANNUAL HIGH-SPEED RESEARCH WORKSHOP, PART 1

ALLEN H. WHITEHEAD, JR., comp. Apr. 1992 482 p Workshop held in Williamsburg, VA, 14-16 May 1991; sponsored by NASA, Washington

(Contract RTOP 537-01-22-01)

(NASA-CP-10087-PT-1; NAS 1.55:10087-PT-1) Avail: CASI HC A21/MF A04

The workshop was presented to provide a national forum for the government, industry, and university participants in the program to present and discuss important technology issues related to the development of a commercially viable, environmentally compatible U.S. High Speed Civil Transport. The workshop sessions were organized around the major task elements in NASA's Phase 1 High Speed Research Program which basically addressed the environmental issues of atmospheric emissions, community noise, and sonic boom. This volume is divided into three sessions entitled: Plenary Session (which gives overviews from NASA, Boeing, Douglas, GE, and Pratt & Whitney on the HSCT program); Airframe Systems Studies; and Atmospheric Effects.

N94-33462* National Aeronautics and Space Administration.
 Langley Research Center, Hampton, VA.

FIRST ANNUAL HIGH-SPEED RESEARCH WORKSHOP, PART 2

ALLEN H. WHITEHEAD, JR., comp. Apr. 1992 521 p Workshop held in Williamsburg, VA, 14-16 May 1991; sponsored by NASA, Washington

(Contract RTOP 537-01-22-01)

(NASA-CP-10087-PT-2; NAS 1.55:10087-PT-2) Avail: CASI HC A22/MF A04

This workshop provided a national forum for presenting and discussing important technology issues related to the definition of an economically viable and environmentally compatible High Speed Civil Transport. The workshop was organized into 13 sessions. This volume is part 2 of 4 and covers 4 of the 13 sessions: (1) source noise; (2) sonic boom (aerodynamic performance); (3) propulsion systems studies; and (4) emission reduction.

N94-33487* National Aeronautics and Space Administration.
 Langley Research Center, Hampton, VA.

FIRST ANNUAL HIGH-SPEED RESEARCH WORKSHOP, PART 3

ALLEN H. WHITEHEAD, JR., comp. Apr. 1992 590 p Workshop held in Williamsburg, VA, 14-16 May 1991; sponsored by NASA, Washington

(Contract RTOP 537-01-22-01)

(NASA-CP-10087-PT-3; NAS 1.55:10087-PT-3) Avail: CASI HC A25/MF A06

The First High-Speed Research (HSR) Workshop was hosted by NASA LaRC and was held 14-16 May 1991, in Williamsburg, Virginia. The purpose of the workshop was to provide a national forum for the government, industry, and university participants to present and discuss important technology issues related to the development of a commercially viable, environmentally compatible, U.S. High-Speed Civil Transport. The workshop sessions are organized around the major task elements in NASA's Phase 1 High-Speed Research Program which basically addresses the environmental issues of atmospheric emissions, community noise, and sonic boom.

N94-33488* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROACOUSTICS ANALYSIS AND COMMUNITY NOISE OVERVIEW

ROBERT A. GOLUB and PAUL T. SODERMAN *In its* First Annual High-Speed Research Workshop, Part 3 p 1065-1071 Apr. 1992
 Avail: CASI HC A02/MF A06

The goals of the High Speed Research Program are focused on three major environmental issues: atmospheric effect, airport community noise, and sonic booms. The issues are basic concerns that require better understanding before further HSRP endeavors can be addresses. This paper discusses airport community noise and aeroacoustic analysis. Autho

N94-33517* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FIRST ANNUAL HIGH-SPEED RESEARCH WORKSHOP, PART 4

ALLEN H. WHITEHEAD, JR., comp. Apr. 1992 390 p Workshop held in Williamsburg, VA, 14-16 May 1991; sponsored by NASA, Washington
 (Contract RTOP 537-01-22-01)
 (NASA-CP-10087-PT-4; NAS 1.55:10087-PT-4) Avail: CASI HC A17/MF A04

Papers presented at the First Annual High Speed Research Workshop held in Williamsburg, Virginia, on May 14-16, 1991 are presented. This NASA-sponsored workshop provided a national forum for presenting and discussing important technology issues related to the definition of an economically viable and environmentally compatible High Speed Civil Transport. The sessions are developed around the technical components of NASA's Phase 1 High Speed Research Program which addresses the environmental issues of atmospheric emissions, community noise, and sonic boom. In particular, this part of the publication, Part 4, addresses high lift research and supersonic laminar flow control.

N94-33518* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OVERVIEW OF NASA HSR HIGH-LIFT PROGRAM
 WILLIAM P. GILBERT *In its* First Annual High-Speed Research Workshop, Part 4 p 1647-1659 Apr. 1992
 Avail: CASI HC A03/MF A04

The viewgraphs and discussion of the NASA High-Speed Research (HSR) Program being conducted to develop the technologies essential for the successful U.S. development of a commercial supersonic air transport in the 2005 timeframe are provided. The HSR program is being conducted in two phases, with the first phase stressing technology to ensure environmental acceptability and the second phase stressing technology to make the vehicle economically viable (in contrast to the current Concorde design). During Phase 1 of the program, a key element of the environmental emphases is minimization of community noise through effective engine nozzle noise suppression technology and through improving the performance of high-lift systems. An overview of the current Phase 1 High-Lift Program, directed at technology for community noise reduction, is presented. The total target for takeoff engine

noise reduction to meet expected regulations is believed to be about 20 EPNdB. The high-lift research is stressing the exploration of innovative high-lift concepts and advanced flight operations procedures to achieve a substantial (approximately 6 EPNdB) reduction in community noise to supplement the reductions expected from engine nozzle noise suppression concepts; primary concern is focused on the takeoff and climbout operations where very high engine power settings are used. Significant reductions in aerodynamic drag in this regime will allow substantial reductions in the required engine thrust levels and therefore reductions in the noise generated. Derived from text

N94-33519* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STATUS OF LARC HSCT HIGH-LIFT RESEARCH

PAUL L. COE *In its* First Annual High-Speed Research Workshop, Part 4 p 1663-1691 Apr. 1992
 Avail: CASI HC A03/MF A04

The viewgraphs for a status report of the NASA Langley Research Center High Speed Civil Transport (HSCT) High-Lift Research Program are provided. A listing of available models and previous wind tunnel studies are presented. Objectives and approach of the piloted simulation program are given. The HSCT High-Lift Research plans are listed and briefly described. CASI

N94-33520* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STATUS OF CFD FOR LARC'S HSR HIGH-LIFT PROGRAM

EDGAR G. WAGGONER and JERRY C. SOUTH, JR. *In its* First Annual High-Speed Research Workshop, Part 4 p 1695-1717 Apr. 1992

Avail: CASI HC A03/MF A04

The viewgraphs for a status report for using computational fluid dynamics (CFD) for NASA Langley's Research Center High Speed Research High-Lift Program are provided. The objectives of CFD applications, the approach to developing appropriate CFD codes, and the dominant flow mechanisms are outlined. Possible CFD codes are compared; graphs comparing force coefficients, surface pressure distribution, and force are included. The plans for using CFD applications are listed. CASI

N94-33521* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

HSR HIGH LIFT RESEARCH PROGRAM: STATUS AND PLANS

JIM ROSE *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 1721-1738 Apr. 1992
 Avail: CASI HC A03/MF A04

The viewgraphs for a report on the status and plans for High Speed Research (HSR) programs are provided. Benefits of improved high lift performance are listed. The objectives, approach, and experimental results are outlined. Future experimental tests and additional research opportunities are listed. The use of computational fluid dynamics (CFD) in high lift research is also outlined. CASI

N94-33522* Boeing Commercial Airplane Co., Seattle, WA.

HSCT HIGH LIFT SYSTEM AERODYNAMIC REQUIREMENTS

JOHN A. PAULSON *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 1741-1763 Apr. 1992

Avail: CASI HC A03/MF A04

The viewgraphs and discussion of high lift system aerodynamic requirements are provided. Low speed aerodynamics has been identified as critical to the successful development of a High Speed Civil Transport (HSCT). The airplane must takeoff and land at a sufficient number of existing or projected airports to be economically viable. At the same time, community noise must be acceptable. Improvements in cruise drag, engine fuel consumption, and structural weight tend to decrease the wing size and thrust required of engines. Decreasing wing size increases the requirements for

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effective and efficient low speed characteristics. Current design concepts have already been compromised away from better cruise wings for low speed performance. Flap systems have been added to achieve better lift-to-drag ratios for climb and approach and for lower pitch attitudes for liftoff and touchdown. Research to achieve improvements in low speed aerodynamics needs to be focused on areas most likely to have the largest effect on the wing and engine sizing process. It would be desirable to provide enough lift to avoid sizing the airplane for field performance and to still meet the noise requirements. The airworthiness standards developed in 1971 will be the basis for performance requirements for an airplane that will not be critical to the airplane wing and engine size. The lift and drag levels that were required to meet the performance requirements of tentative airworthiness standards established in 1971 and that were important to community noise are identified. Research to improve the low speed aerodynamic characteristics of the HSCT needs to be focused in the areas of performance deficiency and where noise can be reduced. Otherwise, the wing planform, engine cycle, or other parameters for a superior cruising airplane would have to be changed.

Derived from text

N94-33523*# Douglas Aircraft Co., Inc., Long Beach, CA.

HSCT HIGH-LIFT TECHNOLOGY REQUIREMENTS

D. L. ANTANI and J. M. MORGENSTERN *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 1767-1788 Apr. 1992

Avail: CASI HC A03/MF A04

The viewgraphs and discussion of high lift needs and related aerodynamic goals established in system studies are described. The goals are presented for the takeoff, approach, and subsonic climb and cruise modes. The status of the related high lift databases and available design and analysis methods are described. Various high lift research and technology areas for future work including innovative concepts verification, flap design, computational fluid dynamics (CFD) calibration and application, high Reynolds number testing, subsonic/transonic flap optimization, and flight testing are described.

CASI

N94-33524*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

LIFT ENHANCEMENT BY TRAPPED VORTEX

VERNON J. ROSSOW *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 1791-1806 Apr. 1992

Avail: CASI HC A03/MF A04

The viewgraphs and discussion of lift enhancement by trapped vortex are provided. Efforts are continuously being made to find simple ways to convert wings of aircraft from an efficient cruise configuration to one that develops the high lift needed during landing and takeoff. The high-lift configurations studied here consist of conventional airfoils with a trapped vortex over the upper surface. The vortex is trapped by one or two vertical fences that serve as barriers to the oncoming stream and as reflection planes for the vortex and the sink that form a separation bubble on top of the airfoil. Since the full three-dimensional unsteady flow problem over the wing of an aircraft is so complicated that it is hard to get an understanding of the principles that govern the vortex trapping process, the analysis is restricted here to the flow field illustrated in the first slide. It is assumed that the flow field between the two end plates approximates a streamwise strip of the flow over a wing. The flow between the endplates and about the airfoil consists of a spanwise vortex located between the suction orifices in the endplates. The spanwise fence or spoiler located near the nose of the airfoil serves to form a separated flow region and a shear layer. The vorticity in the shear layer is concentrated into the vortex by withdrawal of fluid at the suction orifices. As the strength of the vortex increases with time, it eventually dominates the flow in the separated region so that a shear or vertical layer is no longer shed from the tip of the fence. At that point, the vortex strength is fixed and its location is such that all of the velocity contributions at its center

sum to zero thereby making it an equilibrium point for the vortex. The results of a theoretical analysis of such an idealized flow field are described.

Derived from text

N94-33525*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NASA F-16XL SUPERSONIC LAMINAR FLOW CONTROL PROGRAM OVERVIEW

MICHAEL C. FISCHER *In* Its First Annual High-Speed Research Workshop, Part 4 p 1811-1820 Apr. 1992

Avail: CASI HC A02/MF A04

The viewgraphs and discussion of the NASA supersonic laminar flow control program are provided. Successful application of laminar flow control to a High Speed Civil Transport (HSCT) offers significant benefits in reductions of take-off gross weight, mission fuel burn, cruise drag, structural temperatures, engine size, emissions, and sonic boom. The ultimate economic success of the proposed HSCT may depend on the successful adaption of laminar flow control, which offers the single most significant potential improvements in lift drag ratio (L/D) of all the aerodynamic technologies under consideration. The F-16XL Supersonic Laminar Flow Control (SLFC) Experiment was conceived based on the encouraging results of in-house and NASA supported industry studies to determine if laminar flow control is feasible for the HSCT. The primary objective is to achieve extensive laminar flow (50-60 percent chord) on a highly swept supersonic wing. Data obtained from the flight test will be used to validate existing Euler and Navier Stokes aerodynamic codes and transition prediction boundary layer stability codes. These validated codes and developed design methodology will be delivered to industry for their use in designing supersonic laminar flow control wings. Results from this experiment will establish preliminary suction system design criteria enabling industry to better size the suction system and develop improved estimates of system weight, fuel volume loss due to wing ducting, turbocompressor power requirements, etc. so that benefits and penalties can be more accurately assessed.

Derived from text

N94-33526*# Douglas Aircraft Co., Inc., Long Beach, CA.

SUPERSONIC LFC: CHALLENGES AND OPPORTUNITIES

ARTHUR G. POWELL *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 1823-1840 Apr. 1992

Avail: CASI HC A03/MF A04

The discussion and viewgraphs on supersonic laminar control are provided. The high fuel fractions required for long range supersonic airplanes give significant leverage to technologies for cruise drag reduction such as laminar flow control (LFC). Fuel burn benefits are further enhanced when sizing effects are considered. These effects may even be powerful enough to reduce airplane production cost over a turbulent baseline. This is an important goal for LFC technology development. The results of aerodynamics studies on the application of LFC technology to the highly swept wings of supersonic airplanes are presented. Important questions of applicability, realistic benefit, and critical application issues, addressed in a NASA-sponsored study conducted by McDonnell Douglas Corporation in 1987-88 are reviewed. Efforts aimed at establishing the feasibility of demonstrating extensive laminarization on the F-16XL-2 airplane are summarized.

Derived from text

N94-33527*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.

STATUS OF F16XL SSLFC NUMERICAL DESIGN VALIDATION

MIKE GEORGE (Rockwell International Corp., Los Angeles, CA.), MARTA BOHN-MEYER, and BIANCA ANDERSON *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 1843-1889 Apr. 1992

Avail: CASI HC A03/MF A04

The viewgraphs and discussion of the status of the F-16XL SSLFC numerical design validation are provided. The F-16XL Supersonic Laminar Flow Control Program (SSLFC) is a joint effort

involving Rockwell's North American Aircraft Division, NASA Ames-Dryden Flight Research Facility, and NASA Langley Research Center. The objectives of the program are to demonstrate that laminar flow can be obtained on a highly swept wing at supersonic speeds, validate the capabilities of a numerical methodology designed to predict boundary layer transition, and validate the capabilities of the methodology in the design of active and passive laminar flow control (LFC) concepts. The F-16XL SSLFC Program consists of the design, fabrication, installation, and flight test of an active laminar flow control glove for the F-16XL. The glove design emphasized the active (suction) control of attachment line and crossflow boundary condition instabilities. The glove design envelop was constrained by the existing geometry, safety of flight considerations, and space requirements for the suction mechanism. The leading edge extension of the glove was limited to 10 inches for consideration of asymmetric flying qualities and the glove height above the existing surface restricted to two inches. The active (suction) portion of the wing extends to nominally 25 percent chord. The glove was constructed of a micro-perforated titanium sheet (hole diameter = 0.025 inches, spacing ratio = 1/8, and sheet thickness = 0.0025 inches). The glove design includes 22 separate chambers to allow suction variation in the chordwise direction. The F-16XL SSLFC program is currently in the flight test phase. Derived from text

N94-33528*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CODE VALIDATION FOR THE SIMULATION OF SUPERSONIC VISCOUS FLOW ABOUT THE F-16XL
 JOLEN FLORES, EUGENE TU, and LYNDLE KING In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 1893-1908 Apr. 1992
 Avail: CASI HC A03/MF A04

The viewgraphs and discussion on code validation for the simulation of supersonic viscous flow about the F-16XL are provided. Because of the large potential gains related to laminar flow on the swept wings of supersonic aircraft, interest in the applications of laminar flow control (LFC) techniques in the supersonic regime has increased. A supersonic laminar flow control (SLFC) technology program is currently underway within NASA. The objective of this program is to develop the data base and design methods that are critical to the development of laminar flow control technology for application to supersonic transport aircraft design. Towards this end, the program integrates computational investigations underway at NASA Ames-Moffett and NASA Langley with flight-test investigations being conducted on the F-16XL at the NASA Ames-Dryden Research Facility in cooperation with Rockwell International. The computational goal at NASA Ames-Moffett is to integrate a thin-layer Reynolds averaged Navier-Stokes flow solver with a stability analysis code. The flow solver would provide boundary layer profiles to the stability analysis code which in turn would predict transition on the F-16XL wing. To utilize the stability analysis codes, reliable boundary layer data is necessary at off-design cases. Previously, much of the prediction of boundary layer transition has been accomplished through the coupling of boundary layer codes with stability theory. However, boundary layer codes may have difficulties at high Reynolds numbers, of the order of 100 million, and with the current complex geometry in question. Therefore, a reliable code which solves the thin-layer Reynolds averaged Navier-Stokes equations is needed. Two objectives are discussed, the first in greater depth. The first objective is method verification, via comparisons of computations with experiment, of the reliability and robustness of the code. To successfully implement LFC techniques to the F-16XL wing, the flow about the leading edge must be maintained as laminar flow. Therefore, the second objective is to focus on a series of numerical simulations with different values of angle of attack, α , and Reynolds numbers. The purpose of the simulations is to study their effects on the two main factors which precipitate transition to turbulence at leading edges of highly swept wings (e.g., 'spanwise contamination' and 'crossflow instability'). Derived from text

N94-33529*# Vigyan Research Associates, Inc., Hampton, VA.
INVISCID AND VISCOUS FLOW CALCULATIONS FOR THE F-16XL CONFIGURATION
 VENKIT IYER In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 1911-1973 Apr. 1992
 Avail: CASI HC A04/MF A04

The viewgraphs and discussion of the ongoing activity at NASA Langley Research Center (LaRC) in support of Supersonic Laminar Flow Control (SLFC) research, presented at the High-Speed Research Workshop, May 14-16, 1991, are provided. Details of the computation involved in obtaining the meanflow around bodies in high-speed flow and interfacing the results to a stability analysis is presented. Particular attention is given to the F-16XL configuration, which is the test-bed for the supersonic LFC experiment. Meanflow solutions for two geometries are discussed. The first one is for the F-16XL wing, with emphasis on the flow near the attachment line and the upper surface. Calculations were done with and without suction. The results were processed using an interface program and fed into a stability analysis program. The second geometry is a scale model of a swept wing leading edge at $M = 3.5$. Experimental measurements on transition on this model are planned at NASA LaRC. The computations are in support of this effort. Derived from text

N94-33530*# High Technology Corp., Hampton, VA.
LINEAR STABILITY THEORY AND THREE-DIMENSIONAL BOUNDARY LAYER TRANSITION
 ROBERT E. SPALL and MUJEEB R. MALIK In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 1977-1999 Apr. 1992
 Avail: CASI HC A03/MF A04

The viewgraphs and discussion of linear stability theory and three dimensional boundary layer transition are provided. The ability to predict, using analytical tools, the location of boundary layer transition over aircraft-type configurations is of great importance to designers interested in laminar flow control (LFC). The $e(sup N)$ method has proven to be fairly effective in predicting, in a consistent manner, the location of the onset of transition for simple geometries in low disturbance environments. This method provides a correlation between the most amplified single normal mode and the experimental location of the onset of transition. Studies indicate that values of N between 8 and 10 correlate well with the onset of transition. For most previous calculations, the mean flows were restricted to two-dimensional or axisymmetric cases, or have employed simple three-dimensional mean flows (e.g., rotating disk, infinite swept wing, or tapered swept wing with straight isobars). Unfortunately, for flows over general wing configurations, and for nearly all flows over fuselage-type bodies at incidence, the analysis of fully three-dimensional flow fields is required. Results obtained for the linear stability of fully three-dimensional boundary layers formed over both wing and fuselage-type geometries, and for both high and low speed flows are discussed. When possible, transition estimates from the $e(sup N)$ method are compared to experimentally determined locations. The stability calculations are made using a modified version of the linear stability code COSAL. Mean flows were computed using both Navier Stokes and boundary-layer codes. Derived from text

N94-33531*# Boeing Commercial Airplane Co., Seattle, WA.
SUPERSONIC HLFC: POTENTIAL BENEFITS AND TECHNOLOGY DEVELOPMENT REQUIREMENTS
 FRANK NEUMANN In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 4 p 2003-2047 Apr. 1992
 Avail: CASI HC A03/MF A04

The viewgraphs and discussion of the potential benefits and technology development requirements of supersonic Hybrid Laminar Flow Control (HLFC) are reviewed. For the last three years, Boeing has performed studies on the application of laminar flow control to High Speed Civil Transport (HSCT) configurations. Large potential net benefits were identified for laminar flow control, even after accounting for the significant implementation penalties. How-

ever, the technical risks are high at this time, and an early, aggressive technology development program is required if laminar flow control (LFC) is to be incorporated in a year 2005 HSCT program. The benefits and required development effort are addressed. Of all the aerodynamic advances that are being considered for the HSCT, LFC has the largest potential for improving the supersonic lift drag ratio of a given configuration. The work accomplished to date, sponsored by NASA Langley, is summarized. This work includes studies on HLFC application to HSCT, cruise HLFC/low speed boundary layer control (BLC) compatibility, and impact of M 0.9 HLFC and high lift BLC. Requirements for production commitments are listed. The need for a HSCT-HLFC Risk Reduction Program is addressed. Supersonic HLFC development planning and future applications are addressed. Laminar flow/high-lift integration is addressed.

Derived from text

N94-33705* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ICING TEST RESULTS ON AN ADVANCED TWO-DIMENSIONAL HIGH-LIFT MULTI-ELEMENT AIRFOIL

JAIWON SHIN, PETER WILCOX, VINCENT CHIN, and DAVID SHELDON Jun. 1994 22 p Presented at the 12th Applied Aerodynamics Conference, Colorado Springs, CO, 20-22 Jun. 1994; sponsored by AIAA

(Contract RTOP 505-68-10)

(NASA-TM-106620; E-8906; NAS 1.15:106620; AIAA PAPER 94-1869) Avail: CASI HC A03/MF A01

An experimental study has been conducted to investigate ice accretions on a high-lift, multi-element airfoil in the Icing Research Tunnel at the NASA Lewis Research Center. The airfoil is representative of an advanced transport wing design. The experimental work was conducted as part of a cooperative program between McDonnell Douglas Aerospace and the NASA Lewis Research Center to improve current understanding of ice accretion characteristics on the multi-element airfoil. The experimental effort also provided ice shapes for future aerodynamic tests at flight Reynolds numbers to ascertain high-lift performance effects. Ice shapes documented for a landing configuration over a variety of icing conditions are presented along with analyses.

Author

N94-33782# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

A SHOCK TUBE STUDY OF AERODYNAMIC HEATING OF GAPS IN A CYLINDER SUBJECTED TO SUPERSONIC CROSS FLOW M.S. Thesis

DOUGLAS D. HIGH Mar. 1994 265 p

(AD-A278550; AFIT/GA/ENY/94M-2) Avail: CASI HC A12/MF A03

The effects of localized aerodynamic heating in cylinder expansion gaps positioned in cross flow were investigated in a shock tube. For this study, Mach number and Reynolds number were varied from 1.04 to 1.38 and 5×10^5 to 9×10^5 , respectively. The cylinder was instrumented with quick response time thermocouples positioned on the surface of the cylinder, the wall of the gap, and the gap floor. Gap aspect ratios varied from 1.23 to 3.69. Pressure gauges were used to measure wave shock speeds, pressure ratios, and transient pressure conditions. Surface temperatures were measured and converted to heat fluxes using a one-dimensional semi-infinite slab model. Adiabatic wall temperatures were obtained from pressure measurements and ideal gas law relationships. Local nondimensional heat transfer coefficients, Nusselt numbers, were calculated from experimental surface and adiabatic wall temperatures. The present study found a direct dependence on Nusselt number values with Mach number. Peak heating inside the gap was determined to be a function of gap width and location on the cylinder. As gap width was reduced, the location of peak heating on the cylinder varied and Nusselt number values on the floor of the gap dominated.

DTIC

N94-33835 Naval Postgraduate School, Monterey, CA.
CYLINDER DRAG EXPERIMENT: AN UPGRADED

LABORATORY M.S. Thesis

CLAYTON W. MILLER Dec. 1993 111 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A277841) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

A generalized, automated, data acquisition system was designed for the Naval Postgraduate School Aerolab Low Speed Wind Tunnel. A specific application of this system was to upgrade the current Cylinder Drag Experiment conducted during AA2801 Aero Laboratories 1, an introductory aeronautical laboratory course taught at the Naval Postgraduate School. Two methods of drag determination were used: pressure distribution and wake analysis (momentum method). Data from these two methods were collected by a system based on a high speed analog/digital computer board, a standard 486 IBM-type PC, and data acquisition software. Characteristic methods of reducing data from this experiment are discussed. The results obtained by analyzing the acquired data compared favorably to empirical data from previous circular cylinder coefficient of drag experiments. This automated data acquisition system will facilitate future research and instructional use of the wind tunnel.

DTIC

N94-33898* Rockwell International Corp., Huntsville, AL. Space Systems Div.

NUMERICAL SIMULATION OF THE EDGE TONE PHENOMENON Final Report

N. S. DOUGHERTY, B. L. LIU, and J. M. OFARRELL Washington Feb. 1994 71 p Original contains color illustrations

(Contract NAS8-38550)

(NASA-CR-4581; M-744; NAS 1.26:4581) Avail: CASI HC A04/MF A01; 2 functional color pages

Time accurate Navier-Stokes computations were performed to study a class 2 (acoustic) whistle, the edge tone, and to gain knowledge of the vortex-acoustic coupling mechanisms driving production of these tones. Results were obtained by solving the full Navier-Stokes equations for laminar compressible air flow of a two dimensional jet issuing from a slit interacting with a wedge. Cases considered were determined by varying the distance from the slit to the wedge. Flow speed was kept constant at 1,750 cm/s as was the slit thickness of 0.1 cm, corresponding to conditions in the experiments of Brown. The analytical computations revealed edge tones to be present in four harmonic stages of jet flow instability over the wedge as the jet length was varied from 0.3 to 1.6 cm. Excellent agreement was obtained in all four edge tone stage cases between the present computational results and the experimentally obtained frequencies and flow visualization results of Brown. Specific edge tone generation phenomena and further confirmation of certain theories and empirical formulas concerning these phenomena were brought to light in this analytical simulation of edge tones.

Author (revised)

N94-33966# Nielsen Engineering and Research, Inc., Mountain View, CA.

CONTROLLING COMBUSTION AND MAXIMIZING HEAT RELEASE IN A REACTING COMPRESSIBLE FREE SHEAR LAYER Final Report, 15 Dec. 1990 - 15 Dec. 1993

DAVID NIXON and LAURENCE R. KEEFE 11 Feb. 1994 38 p

(Contract F49620-91-C-0020)

(AD-A278328; NERI-TR-476; AFOSR-94-0167TR) Avail: CASI HC A03/MF A01

The objective of this work has been to study the interaction between heat release and mixing in compressible shear layers by analysis and computation, with an eye to finding flow configurations that maximize the heat release per unit distance in the stream direction. The principal prediction is that heat release asymmetry across the layer can enhance mixing over the non-heat release case, but the effect appears too small to yield practical benefits at this time. Time dependent, three-dimensional numerical simulations of a shear layer with weak, steady heat release have shown that such heat release need not decrease mixing but the expected

increases are also absent, or too small to be detected currently. However, the original non-heat-release theory has been successfully extended to predict the mixing behavior of three-dimensional planar layers and round compressible jets. This bolsters confidence in the generality of the principles underlying the analysis. Invoking a mixing maximum principle, the extended theory gives a satisfactory analytic expression for mixing ratio when $M(\text{sub } c)$ is less than or equal to 3. A variational formulation of the heat release problem with a functional dependent on the square of streamline curvature has proved intractable. DTIC

N94-33991* Florida Atlantic Univ., Boca Raton, FL. Dept. of Mechanical Engineering.

SENSITIVITY OF LAG-DAMPING CORRELATIONS TO STRUCTURAL AND AERODYNAMIC APPROXIMATIONS OF ISOLATED EXPERIMENTAL ROTORS IN FORWARD FLIGHT
Interim Technical Report, 1 Aug. 1992 - 21 Dec. 1993

G. H. GAONKAR, S. SUBRAMANIAN, and SRINIVAS CHUNDURU
Apr. 1994 44 p Prepared for Army Aviation Research and Development Command, Moffett Field, CA
(Contract NAG2-797)
(NASA-CR-195822; NAS 1.26:195822) Avail: CASI HC A03/MF A01

The predictions of regressive lag-mode damping levels are correlated with the database of an isolated, soft-inplane, three-blade rotor operated untrimmed. The database was generated at the Army Aeroflightdynamics Directorate at Ames. The correlation covers a broad range of data, from near-zero thrust conditions in hover to high-thrust and highly stalled conditions in forward flight with advance ratio as high as 0.55 and shaft angle as high as 20 degrees. In the experimental rotor, the airfoil or blade portion has essentially uniform mass and stiffness distributions, but the root flexure has highly nonuniform mass and stiffness distributions. Accordingly, the structural approximations refer to four models of root-flexure-blade assembly. They range from a rigid flap-lag model to three elastic flap-lag-torsion models, which differ in modeling the root flexure. The three models of root-flexure are: three root springs in which the bending-torsion couplings are fully accounted for; a finite-length beam element with some average mass and stiffness distributions such that the fundamental frequencies match those of the experimental model; and accurate modal representation in which the actual mass and stiffness distributions of the experimental root-flexure-blade assembly are used in calculating the nonrotating mode shapes. The four models of root-flexure-blade assembly are referred to as the rigid flap-lag model, spring model, modified model and modal model. For each of these four models of the root-flexure-blade assembly, the predictions are based on the following five aerodynamic theories: ear theory, which accounts for large angle-of-attack and reverse-flow effects on lift, and has constant drag and pitching moment; quasisteady stall theory, which includes quasisteady stall lift, drag and pitching moment characteristics of the airfoil section, dynamics stall theory, which uses the ONERA dynamic stall models of lift, drag and pitching moment; dynamic wake theory, which is based on a finite-state three-dimensional wake model and includes all wake effects including both shed and trailing vorticity; and dynamics and wake theory, which combines both dynamic stall theory and dynamic wake theory and is a relatively complete aerodynamic representation. Derived from text

N94-33995* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

FURTHER DEVELOPMENT AND FLIGHT TEST OF AN AUTONOMOUS PRECISION LANDING SYSTEM USING A PARAFOL

JAMES E. MURRAY, ALEX G. SIM, DAVID C. NEUFELD, PATRICK K. RENNICH, STEPHEN R. NORRIS, and WESLEY S. HUGHES
Jul. 1994 12 p Presented at the 6th Biennial Flight Test Conference, Colorado Springs, CO, 20-23 Jun. 1994
(Contract RTOP 505-68-50)
(NASA-TM-4599; H-1987; NAS 1.15:4599; AIAA PAPER 94-2141)
Avail: CASI HC A03/MF A01

NASA Dryden Flight Research Center and NASA Johnson Space Center are jointly conducting a phased program to determine the feasibility of the autonomous recovery of a spacecraft using a ram-air parafoil system for the final stages of entry from space to a precision landing. The feasibility is being studied using a flight model of a spacecraft in the generic shape of a flattened biconic that weighs approximately 120 lb and is flown under a commercially available ram-air parafoil. Key components of the vehicle include the global positioning system (GPS) guidance for navigation, a flight control computer, an electronic compass, a yaw rate gyro, and an onboard data recorder. A flight test program is being used to develop and refine the vehicle. The primary flight goal is to demonstrate autonomous flight from an altitude of 3,000 m (10,000 ft) with a lateral offset of 1.6 km (1.0 mi) to a precision soft landing. This paper summarizes the progress to date. Much of the navigation system has been tested, including a heading tracker that was developed using parameter estimation techniques and a complementary filter. The autoland portion of the autopilot is still in development. The feasibility of conducting the flare maneuver without servoactuators was investigated as a means of significantly reducing the servoactuator rate and load requirements. Author (revised)

N94-33997* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NASA AMES FLUID MECHANICS LABORATORY RESEARCH BRIEFS

SANFORD DAVIS, ed. May 1994 24 p
(Contract RTOP 505-59-50)
(NASA-TM-108818; A-94073; NAS 1.15:108818) Avail: CASI HC A03/MF A01

The Ames Fluid Mechanics Laboratory research program is presented in a series of research briefs. Nineteen projects covering aeronautical fluid mechanics and related areas are discussed and augmented with the publication and presentation output of the Branch for the period 1990-1993. Author

N94-34159* JAI Associates, Inc., Mountain View, CA.

A FREE-WAKE EULER AND NAVIER-STOKES CFD METHOD AND ITS APPLICATION TO HELICOPTER ROTORS INCLUDING DYNAMIC STALL Final Report, Apr. 1990 - Nov. 1993

GANAPATHI R. SRINIVASAN Nov. 1993 119 p
(Contract DAAL03-90-C-0013)
(AD-A278000; TR-93-01) Avail: CASI HC A06/MF A02

This report summarizes the results of the research in two parts. Part 1 describes the development and application of a free-wake Euler and Navier-Stokes computational fluid dynamics method, called TURNS, for helicopter applications. This finite-difference, implicit, upwind numerical method uses structured grids, and has been used for calculating the viscous, three-dimensional flowfields of rotors in hover, forward flight, blade-vortex interactions, and high speed impulsive noise. The good agreement of numerical results with experiments for surface pressures, wake trajectory, thrust, power, figure of merit, and acoustic wave forms indicate the accuracy and suitability of the numerical method. It is demonstrated that both aerodynamics and acoustics information can be obtained in a single solution of the governing equations. In Part 2, the unsteady flowfield results of a two-dimensional oscillating wing are presented for five widely used turbulence models and compared with experiments. The accuracy and suitability of turbulence models for unsteady separated flow are discussed. DTIC

N94-34172* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STATIC PERFORMANCE INVESTIGATION OF A SKEWED-THROAT MULTIAXIS THRUST-VECTERING NOZZLE CONCEPT

DAVID J. WING Apr. 1994 126 p
(Contract RTOP 505-62-30-01)
(NASA-TP-3411; L-17271; NAS 1.60:3411) Avail: CASI HC A07/MF A02

The static performance of a jet exhaust nozzle which achieves multiaxis thrust vectoring by physically skewing the geometric throat has been characterized in the static test facility of the 16-Foot Transonic Tunnel at NASA Langley Research Center. The nozzle has an asymmetric internal geometry defined by four surfaces: a convergent-divergent upper surface with its ridge perpendicular to the nozzle centerline, a convergent-divergent lower surface with its ridge skewed relative to the nozzle centerline, an outwardly deflected sidewall, and a straight sidewall. The primary goal of the concept is to provide efficient yaw thrust vectoring by forcing the sonic plane (nozzle throat) to form at a yaw angle defined by the skewed ridge of the lower surface contour. A secondary goal is to provide multiaxis thrust vectoring by combining the skewed-throat yaw-vectoring concept with upper and lower pitch flap deflections. The geometric parameters varied in this investigation included lower surface ridge skew angle, nozzle expansion ratio (divergence angle), aspect ratio, pitch flap deflection angle, and sidewall deflection angle. Nozzle pressure ratio was varied from 2 to a high of 11.5 for some configurations. The results of the investigation indicate that efficient, substantial multiaxis thrust vectoring was achieved by the skewed-throat nozzle concept. However, certain control surface deflections destabilized the internal flow field, which resulted in substantial shifts in the position and orientation of the sonic plane and had an adverse effect on thrust-vectoring and weight flow characteristics. By increasing the expansion ratio, the location of the sonic plane was stabilized. The asymmetric design resulted in interdependent pitch and yaw thrust vectoring as well as nonzero thrust-vector angles with undeflected control surfaces. By skewing the ridges of both the upper and lower surface contours, the interdependency between pitch and yaw thrust vectoring may be eliminated and the location of the sonic plane may be further stabilized.

Author

N94-34204* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THIRD-ORDER 2N-STORAGE RUNGE-KUTTA SCHEMES WITH ERROR CONTROL
 MARK H. CARPENTER and CHRISTOPHER A. KENNEDY Jun. 1994 17 p
 (Contract RTOP 505-70-62-13)
 (NASA-TM-109111; NAS 1.15:109111) Avail: CASI HC A03/MF A01

A family of four-stage third-order explicit Runge-Kutta schemes is derived that requires only two storage locations and has desirable stability characteristics. Error control is achieved by embedding a second-order scheme within the four-stage procedure. Certain schemes are identified that are as efficient and accurate as conventional embedded schemes of comparable order and require fewer storage locations.

Author

N94-34207* Virginia Polytechnic Inst., Blacksburg. Aerospace and Ocean Engineering Dept.
FLOW STRUCTURE GENERATED BY PERPENDICULAR BLADE VORTEX INTERACTION AND IMPLICATIONS FOR HELICOPTER NOISE PREDICTIONS Semiannual Report, 19 Oct. 1993 - 19 Apr. 1994
 WILLIAM J. DEVENPORT and STEWART A. L. GLEGG 1994 5 p
 (Contract NAG1-1539)
 (NASA-CR-195824; NAS 1.26:195824) Avail: CASI HC A01/MF A01

Activities carried out in support of research on flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise prediction are summarized. Progress in the following areas is described: (1) construction of 8 inch-chord NACA 0012 full-span blade; (2) Acquisition of two full-span blades; (3) preparation for hot wire measurements; (4) related work on a modified Betz's theory; and (5) work related to helicopter noise prediction. In addition, a list of publications based on the results of prior experimentation is presented.

CASI

N94-34277* MCAT Inst., San Jose, CA.
COMPUTATIONAL STUDY OF GENERIC HYPERSONIC VEHICLE FLOW FIELDS Final Report
 JOHNNY R. NARAYAN Apr. 1994 70 p Original contains color illustrations
 (Contract NCC2-715)
 (NASA-CR-195938; NAS 1.26:195938; MCAT-94-03) Avail: CASI HC A04/MF A01; 9 functional color pages

The geometric data of the generic hypersonic vehicle configuration included body definitions and preliminary grids for the forebody (nose cone excluded), midsection (propulsion system excluded), and afterbody sections. This data was to be augmented by the nose section geometry (blunt conical section mated with the noncircular cross section of the forebody initial plane) along with a grid and a detailed supersonic combustion ramjet (scramjet) geometry (inlet and combustor) which should be merged with the nozzle portion of the afterbody geometry. The solutions were to be obtained by using a Navier-Stokes (NS) code such as TUFF for the nose portion, a parabolized Navier-Stokes (PNS) solver such as the UPS and STUFF codes for the forebody, a NS solver with finite rate hydrogen-air chemistry capability such as TUFF and SPARK for the scramjet and a suitable solver (NS or PNS) for the afterbody and external nozzle flows. The numerical simulation of the hypersonic propulsion system for the generic hypersonic vehicle is the major focus of this entire work. Supersonic combustion ramjet is such a propulsion system, hence the main thrust of the present task has been to establish a solution procedure for the scramjet flow. The scramjet flow is compressible, turbulent, and reacting. The fuel used is hydrogen and the combustion process proceeds at a finite rate. As a result, the solution procedure must be capable of addressing such flows.

Derived from text

N94-34384* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
X-29 FLIGHT CONTROL SYSTEM: LESSONS LEARNED
 ROBERT CLARKE, JOHN J. BURKEN, JOHN T. BOSWORTH, and JEFFERY E. BAUER Jun. 1994 17 p Presented at the AGARD Flight Mechanics Panel Symposium, Turin, Italy, 9-12 May 1994
 (Contract RTOP 505-64-30)
 (NASA-TM-4598; H-1995; NAS 1.15:4598) Avail: CASI HC A03/MF A01

Two X-29A aircraft were flown at the NASA Dryden Flight Research Center over a period of eight years. The airplanes' unique features are the forward-swept wing, variable incidence close-coupled canard and highly relaxed longitudinal static stability (up to 35-percent negative static margin at subsonic conditions). This paper describes the primary flight control system and significant modifications made to this system, flight test techniques used during envelope expansion, and results for the low- and high-angle-of-attack programs. Through out the paper, lessons learned will be discussed to illustrate the problems associated with the implementation of complex flight control systems.

Author

N94-34391* Akron Univ., OH. Dept. of Mechanical Engineering.
A QUALITATIVE AND QUANTITATIVE LASER-BASED COMPUTER-AIDED FLOW VISUALIZATION METHOD M.S. Thesis, 1992 Final Report
 VICTOR A. CANACCI and M. JACK BRAUN May 1994 205 p
 (Contract NCC3-93; NCC3-165; RTOP 505-62-52)
 (NASA-CR-195300; E-8692; NAS 1.26:195300) Avail: CASI HC A10/MF A03

The experimental approach presented here offers a nonintrusive, qualitative and quantitative evaluation of full field flow patterns applicable in various geometries in a variety of fluids. This Full Flow Field Tracking (FFFT) Particle Image Velocimetry (PIV) technique, by means of particle tracers illuminated by a laser light sheet, offers an alternative to Laser Doppler Velocimetry (LDV), and intrusive systems such as Hot Wire/Film Anemometry. The method makes obtainable the flow patterns, and allows quantitative determination of the velocities, accelerations, and mass flows of an entire

flow field. The method uses a computer based digitizing system attached through an imaging board to a low luminosity camera. A customized optical train allows the system to become a long distance microscope (LDM), allowing magnifications of areas of interest ranging up to 100 times. Presented in addition to the method itself, are studies in which the flow patterns and velocities were observed and evaluated in three distinct geometries, with three different working fluids. The first study involved pressure and flow analysis of a brush seal in oil. The next application involved studying the velocity and flow patterns in a cowl lip cooling passage of an air breathing aircraft engine using water as the working fluid. Finally, the method was extended to a study in air to examine the flows in a staggered pin arrangement located on one side of a branched duct.

Author

N94-34430* Eidetics International, Inc., Torrance, CA.
F/A-18 FOREBODY VORTEX CONTROL. VOLUME 2: ROTARY-BALANCE TESTS
 BRIAN R. KRAMER, CARLOS J. SUAREZ, GERALD N. MALCOLM, and BERT F. AYERS Mar. 1994 217 p
 (Contract NAS2-13383)
 (NASA-CR-4582; A-94055; NAS 1.26:4582) Avail: CASI HC A10/MF A03

A rotary-balance wind tunnel test was conducted on a six percent model of the F/A-18 at the NASA Ames 7 X 10-Foot Low Speed Wind Tunnel. The data reduction was specially written for the test in National Instruments' LabVIEW. The data acquisition, reduction and analysis was performed with a Macintosh computer. The primary objective of the test was to evaluate the effectiveness of several forebody vortex control configurations in a rotary flow field. The devices that were found to be the most effective during the static tests (Volume 1) were investigated and included both mechanical and pneumatic configurations. The mechanical systems evaluated were small, single and dual, rotating nose tip strakes and a vertical nose strake. The jet blowing configuration used nozzles canted inboard 60 degrees. A two segment tangential slot was also evaluated. The different techniques were evaluated at angles of attack of 30 degrees, 45 degrees, 51 degrees, and 60 degrees. Sideslip and Reynolds number were varied for some of the configurations. All of the techniques proved to be effective in the rotating flow field. The vertical nose strake had the largest 'envelope' of effectiveness. Forebody vortex control provides large, robust yawing moments at medium to high angles of attack, even during combat maneuvers such as loaded roll.

Author

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

N94-32454* Axiomatics Corp., Woburn, MA.
CONTINUOUS MEASUREMENT OF AIRCRAFT WING ICING
 STEPHEN S. C. YAO In NASA, Washington, Technology 2003: The Fourth National Technology Transfer Conference and Exposition, Volume 2 p 295-300 Feb. 1994
 Avail: CASI HC A02/MF A04

Ice formation on the wings of aircraft is a problem that has plagued air travel since its inception. Several recent incidents have been attributed to ice formation on the lifting surfaces of wings. This paper describes a SBIR Phase 1 research effort on the use of small flat dielectric sensors in detecting a layer of ice above the sensor. The sensors are very small, lightweight, and inexpensive. The electronics package that controls the sensor is also small, and could be even smaller using commonly available miniaturization technologies. Thus, several sensors could be placed on a surface such that a representative ice thickness profile could be measured. The benefits offered by developing this technology go beyond the safety

improvements realized by monitoring ice formation on the wings of an aircraft. Continuous monitoring of anti-icing fluid concentrations on the ground would warn the pilot of impending fluid failure as well as allowing the stations to use less de-icing solution per aircraft. This in turn would increase the safety of takeoffs and reduce the overall discharge of de-icing solution into the environment, thus reducing the biohazard of the de-icing procedure.

Author

N94-32620* Mitre Corp., McLean, VA.
THE 1993 AVIATION SYSTEM CAPACITY PLAN
 1993 367 p Prepared in cooperation with MiTech, Inc., Rockville, MD and JIL Systems, Inc., Arlington, VA
 (AD-A276958; DOT/FAA/ASC-93-1) Avail: CASI HC A16/MF A03

This is a comprehensive review of the Federal Aviation Administration's program to improve the capacity of the National Air Transportation System. The Plan identifies the causes and extent of capacity and delay problems currently associated with air travel in the U.S. and outlines various planned and ongoing FAA projects that will reduce the severity of the problems in the future. The major areas of discussion are: airport development, airport and airspace capacity, technology for capacity improvement, and marketplace solutions.

DTIC

N94-32925* National Transportation Safety Board, Washington, DC.
ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA: US AIR CARRIER OPERATIONS, CALENDAR YEAR 1991
 15 Apr. 1994 74 p
 (PB94-158847; NTSB/ARC-94/01) Avail: CASI HC A04/MF A01

This publication presents the record of aviation accidents involving revenue operations of U.S. Air Carriers including Commuter Air Carriers and On Demand Air Taxis for calendar year 1991. The report is divided into three major sections according to the federal regulations under which the flight was conducted - 14 CFR 121, 125, 127, Scheduled 14 CFR 135, or Nonscheduled 14 CFR 135. In each section of the report tables are presented to describe the losses and characteristics of 1991 accidents to enable comparison with prior years.

Author

N94-32927* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AVIATION HUMAN FACTORS RESEARCH IN US UNIVERSITIES: POTENTIAL CONTRIBUTIONS TO NATIONAL NEEDS
 R. KEY DISMUKES Mar. 1994 21 p
 (Contract RTOP 505-64-13)
 (NASA-TM-108814; A-94060; NAS 1.15:108814) Avail: CASI HC A03/MF A01

Universities can and should make vital contributions to national needs in aviation human factors. However, to guide and utilize university research effectively we must understand what types of expertise and facilities universities can bring to bear on aviation problems. We should be aware of where relevant research is already underway and where untapped potential exists. How does the character of research in universities differ from and complement research in government and industry laboratories? What conditions would encourage universities to focus on national priorities and would promote high quality, relevant research? This paper attempts to address these issues. It is based on a survey conducted by the author, which included site visits to several universities, telephone interviews with faculty members at other universities, and a search of the aviation human factors research literature.

Author

N94-32938* National Transportation Safety Board, Washington, DC.
AIRCRAFT INCIDENT REPORT: IN-FLIGHT TURBULENCE ENCOUNTER AND LOSS OF PORTIONS OF THE ELEVATORS, CHINA AIRLINES FLIGHT CI-012, MCDONNELL DOUGLAS MD-11-P, TAIWAN REGISTRATION B-150 ABOUT 20 MILES

03 AIR TRANSPORTATION AND SAFETY

EAST OF JAPAN, 7 DECEMBER 1992

15 Feb. 1994 58 p

(PB94-910403; NTSB/AAR-94/02) Avail: CASI HC A04/MF A01

This report explains the in-flight turbulence encounter of China Airlines flight CI-012, an MD-11 airplane, which subsequently departed controlled flight and sustained damage to the outboard elevators, portions of which separated from the airplane, on 7 Dec. 1992, about 20 miles east of Japan. The safety issues discussed in the report include the design and certification of the MD-11. Safety recommendations concerning these issues were made to the Federal Aviation Administration. Author (revised)

N94-32955# Federal Aviation Administration, Atlantic City, NJ. Technical Center.

CIVIL TILTROTOR MARKET PENETRATION: EFFECTS ON NORTHEAST CORRIDOR AIRPORT DELAY

ANNY S. CHEUNG and DOUGLAS BAART Feb. 1994 38 p

(AD-A277534; DOT/FAA/CT-TN94/1; FAA-AOR-100-94-001) Avail: CASI HC A03/MF A01

This report addresses the delay impacts resulting from replacing conventional aircraft services with civil tiltrotor (CTR) operations in the Northeast corridor at four CTR service levels. This analysis was conducted by using the National Airspace System performance analysis capability (NASPAC) simulation modeling system (SMS). Cost of delay savings were derived by using the cost of delay module. The result of this study will be used by the Vertical Flight Program Office (ARD-30) in assessing the benefits of the CTR operations in the Northeast corridor. DTIC

N94-33063*# San Jose State Univ., CA.

THREE DIMENSIONAL AUDIO VERSUS HEAD DOWN TCAS DISPLAYS

DURAND R. BEGAULT and MARC T. PITTMAN Mar. 1994 14 p

(Contract NCC2-327)

(NASA-CR-177636; A-94066; NAS 1.26:177636) Avail: CASI HC A03/MF A01

The advantage of a head up auditory display was evaluated in an experiment designed to measure and compare the acquisition time for capturing visual targets under two conditions: Standard head down traffic collision avoidance system (TCAS) display, and three-dimensional (3-D) audio TCAS presentation. Ten commercial airline crews were tested under full mission simulation conditions at the NASA Ames Crew-Vehicle Systems Research Facility Advanced Concepts Flight Simulator. Scenario software generated targets corresponding to aircraft which activated a 3-D aural advisory or a TCAS advisory. Results showed a significant difference in target acquisition time between the two conditions, favoring the 3-D audio TCAS condition by 500 ms. Author

N94-33563* National Aeronautics and Space Administration, Washington, DC.

AIRLINE SAFETY AND ECONOMY (Videotape)

1993 Videotape: 6 min. 30 sec. playing time, in color, with sound (NASA-TM-109811; NONP-VT-94-12939) Avail: CASI VHS A01/BETA A22

This video documents efforts at NASA Langley Research Center to improve safety and economy in aircraft. Featured are the cockpit weather information needs computer system, which relays real time weather information to the pilot, and efforts to improve techniques to detect structural flaws and corrosion, such as the thermal bond inspection system. CASI

N94-33749* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CRASH IMPACT SURVIVAL IN LIGHT PLANES (Videotape)

1994 Videotape: 7 min. 45 sec. playing time, in color, with sound (NASA-TM-109799; NONP-VT-94-12927) Avail: CASI VHS A01/BETA A22

This video explains the effects on aircraft and passengers of light plane crashes. The explanation is provided through the use of simulated light planes and dummies. CASI

N94-33943*# San Jose State Univ., CA.

ON THE DESIGN OF FLIGHT-DECK PROCEDURES

ASAF DEGANI and EARL L. WIENER Jun. 1994 70 p

(Contract NCC2-327; NCC2-581)

(NASA-CR-177642; A-94095; NAS 1.26:177642) Avail: CASI HC A04/MF A01

In complex human-machine systems, operations, training, and standardization depend on a elaborate set of procedures which are specified and mandated by the operational management of the organization. The intent is to provide guidance to the pilots, to ensure a logical, efficient, safe, and predictable means of carrying out the mission objectives. In this report the authors examine the issue of procedure use and design from a broad viewpoint. The authors recommend a process which we call 'The Four P's': philosophy, policies, procedures, and practices. We believe that if an organization commits to this process, it can create a set of procedures that are more internally consistent, less confusing, better respected by the flight crews, and that will lead to greater conformity. The 'Four-P' model, and the guidelines for procedural development in appendix 1, resulted from cockpit observations, extensive interviews with airline management and pilots, interviews and discussion at one major airframe manufacturer, and an examination of accident and incident reports. Although this report is based on airline operations, we believe that the principles may be applicable to other complex, high-risk systems, such as nuclear power production, manufacturing process control, space flight, and military operations. Author (revised)

N94-33956*# Polytechnic Univ., Farmingdale, NY. Dept. of Computer Science.

A STUDY OF OCCURRENCE RATES OF ELECTROMAGNETIC INTERFERENCE (EMI) TO AIRCRAFT WITH A FOCUS ON HIRF (EXTERNAL) HIGH INTENSITY RADIATED FIELDS Final Report

MARTIN L. SHOOMAN Apr. 1994 98 p

(Contract NAG1-1272; RTOP 505-64-10)

(NASA-CR-194895; NAS 1.26:194895) Avail: CASI HC A05/MF A02

This report presents the methodology and results of a subjective study done by Polytechnic University to investigate Electromagnetic Interference (EMI) events on aircraft. The results cover various types of EMI from on-board aircraft systems, passenger carry-on devices, and externally generated disturbances. The focus of the study, however, was on externally generated EMI, termed High Intensity Radiated Fields (HIRF), from radars, radio and television transmitters, and other man-made emitters of electromagnetic energy. The study methodology used an anonymous questionnaire distributed to experts to gather the data. This method is known as the Delphi or Consensus Estimation technique. The questionnaire was sent to an expert population of 230 and there were 57 respondents. Details of the questionnaire, a few anecdotes, and the statistical results of the study are presented. Author

N94-34390# National Transportation Safety Board, Washington, DC.

AIRCRAFT ACCIDENT REPORT: CONTROLLED FLIGHT INTO TERRAIN FEDERAL AVIATION ADMINISTRATION BEECH SUPER KING AIR 300/F, N82, FRONT ROYAL, VIRGINIA, 26 OCTOBER 1993

12 Apr. 1994 111 p

(PB94-910405; NTSB/AAR-94/03) Avail: CASI HC A06/MF A02

This report explains the crash into mountainous terrain of a Beech Super King Air 300/F, N82, owned by the Federal Aviation Administration, near Front Royal, Virginia, on October 26, 1993. The safety issues discussed in the report focused on the Federal Aviation Administration's flying program operations and the flight

safety management system. Recommendations concerning these issues were addressed to the Federal Aviation Administration.
Author

N94-34401 Federal Aviation Administration, Washington, DC.
FEDERAL AVIATION REGULATIONS. PART 91: GENERAL OPERATING AND FLIGHT RULES, CHANGE 4

5 Oct. 1993 22 p See also PB94-159910 and PB94-105392
Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-159944) Avail: CASI HC A03

This subpart prescribes flight rules governing the operation of aircraft within the United States and within 12 nautical miles from the coast of the United States. NTIS

N94-34410 Federal Aviation Administration, Washington, DC.
FEDERAL AVIATION REGULATIONS. PART 91: GENERAL OPERATING AND FLIGHT RULES, CHANGE 3

16 Sep. 1993 26 p See also PB94-159944 and PB94-105392
Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(PB94-159910) Avail: CASI HC A03

This subpart prescribes flight rules governing the operation of aircraft within the United States and within 12 nautical miles from the coast of the United States. NTIS

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

N94-32505 Artificial Intelligence Management and Development Corp., Toronto (Ontario).

PLAN RECOGNITION FOR AN AIR TRAFFIC CONTROL SIMULATION Interim Report

Sep. 1993 102 p
(DSIS-94-01221; CTN-94-61217) Copyright Avail: CASI HC A06/MF A02

Experiments were conducted in which human subjects performed an air traffic control simulation. Based on the results of that experimental study, work was then started on designing and developing a system for recognizing and predicting the subjects' plans for the aircraft as they fly through the simulation airspace. In designing the experimental study, results were used from pilot research which suggested that it would be possible to bring naive subjects to a level of play so that their results could be used in the development of a system to predict reliably the plans of other future subjects in the simulation. The pilot research results were used to design an experiment to collect data for use in developing the plan recognizer. The experimental design and procedure used are described, as well as the simulation airspace and its properties. The highest level of decomposition of the plan recognizer is reviewed with respect to four elements of the system's architecture: an air traffic control simulation; a database of session statistics, initial information about aircraft and airports, interface action information, and abstract plans for aircraft; a Nexpert Object expert system, which operates in the background to access database information and infer plans; and a Hypercard display component. Author (CISTI)

N94-32961 Department of the Navy, Washington, DC.

RELATIVE MOTION PINWHEEL Patent

GARY E. STREIMER, inventor (to Navy) and LESLIE P. BENDA, inventor (to Navy) 30 Nov. 1993 6 p Filed 5 Oct. 1991
(AD-D016107; US-PATENT-APPL-SN-956327; US-PATENT-

CLASS-33-1-SB) Avail: US Patent and Trademark Office

An apparatus for visualizing relative motion between two moving objects in a two-dimensional plane is provided. A planar base has a first compass rose printed thereon. Rotatably attached to the center of the first compass rose is a means for indicating a present course of a first moving object relative to a true bearing indication on the first compass rose. A second moving object assembly consists of a second compass rose rotatably attached to a means for indicating a present course of the second moving object relative to a true bearing indication on the second compass rose. The true bearing indication on the second compass rose is aligned to be equivalent to the true bearing indication on the first compass rose. Attached at the centers of the first and second compass roses is a means for tethering the second moving object assembly to the first compass rose. The second compass rose is free to rotate about its center, and the second moving object assembly is free to revolve in a single plane around the center of the first compass rose. The tethering means indicates a line of relative bearing from the first moving object to the second moving object. DTIC

N94-33095# Army Topographic Engineering Center, Fort Belvoir, VA.

REAL-TIME CENTIMETER POSITIONING WITH GPS: A SYSTEM DEVELOPED BY THE US ARMY CORPS OF ENGINEERS

SALLY L. FRODGE, BENJAMIN REMONDI, and DARIUSZ LAPUCHA 11 Apr. 1994 11 p
(AD-A278152; R-223) Avail: CASI HC A03/MF A01

The United States Army Corps of Engineers has been developing a Global Positioning System (GPS) carrier phase based positioning system for hydrographic surveying and dredging since 1988. This system provides real-time three-dimensional positions with horizontal and vertical accuracies better than 1 decimeter over ranges up to 20 kilometers from a single reference station without static initialization. The project has passed from concept development through feasibility studies, system analysis, resolution of carrier ambiguities on-the-fly (OTF), to final system integration which is nearing completion. The real-time testing of the system began in March of 1993. This testing was performed under varying operating conditions to evaluate the limits of OTF ambiguity resolution for precisely positioning moving platforms. This paper summarizes the results of those tests. Early real-time tests performed have shown 1-3 centimeters in all three dimensions. The final design of the real-time system and its integration to hydrographic survey platforms are also discussed. DTIC

N94-33253 Naval Command, Control and Ocean Surveillance Center, San Diego, CA. RDT and E Div.

AN EVALUATION OF THREE GPS RECEIVERS FOR USE IN THE GPS SOUNDER Final Report, period ending Oct. 1993

K. D. ANDERSON Apr. 1994 53 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract ONR PROJ. R035S83)
(AD-A278157; NCCOSC/RDT/E-TR-1637) Avail: CASI HC A04

Three high performance, geodetic quality, Global Positioning System (GPS) receivers were tested at the Naval Command, Control and Ocean Surveillance Center RDT and E Division to evaluate their use in supporting the GPS Sounder. These tests are focused on comparisons of the signal-to-noise ratio (SNR) of the GPS satellite is either rising or setting on the ocean horizon. Of primary interest is the ability of the receiver to lock onto and track the GPS signals when the satellite is at elevation angles of less than 1 degree. This requirement is unique to the GPS Sounder and is one of the most stressful conditions for receiving processing. In most applications, GPS signals never examined at ground-to-satellite elevation angles of less than about 15 degrees because of multipath effects on signal reception. However, the ability to lock onto and track the GPS signals in the presence of severe multipath conditions is crucial to the success of the GPS Sounder. DTIC

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

N94-33412# Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

PILOT GPS/LORAN RECEIVER PROGRAMMING

PERFORMANCE: A LABORATORY EVALUATION Final Report, May 1992 - Sep. 1993

EDWIN F. MADIGAN, JR., VICKI M. SHEARER, DONALD ELDREDGE, and M. S. HUNTLEY, JR. Feb. 1994 103 p (AD-A278258; DOT-VNTSC-FAA-93-20) Avail: CASI HC A06/MF A02

This study was designed to explore GPS/LORAN receiver programming performance under simulated flight conditions. The programming task consisted of entering, editing, and verifying a four-waypoint flight plan. The task demands were manipulated by varying flight turbulence and the time interval between test sessions. Flight performance data indicated that subjects were well trained on the flight task; significant effects of turbulence and test interval were not found. Programming performance was very good and critical errors occurred on only 13% of the test trials. Examination of the conditions surrounding each error indicated that specific display design and system logic attributes contributed to the errors. In addition, examination of error recovery methods showed that non-intuitive menu structures complicated and confused the recovery process. Pilots rarely recalled 'doing anything wrong' when errors occurred, suggesting that the receiver interface design was opaque and did not provide a good understanding of system function. Recommendations for GPS/LORAN receiver controls, functions, menu structure and logic, error recognition and recovery, and general usability are discussed. DTIC

N94-33534*# Scripps Institution of Oceanography, La Jolla, CA. **PERMANENT GPS GEODETIC ARRAY IN SOUTHERN CALIFORNIA (PGGA) AND GPS OBSERVATIONS IN INDONESIA Final Technical Report, 1 Oct. 1990 - 31 Mar. 1993**

YEHUDS BOCK 18 May 1994 6 p (Contract NAGW-2641) (NASA-CR-195897; NAS 1.26:195897) Avail: CASI HC A02/MF A01

The Permanent GPS Geodetic Array (PGGA) is a network of permanent monitoring GPS stations in southern California devoted to the continuous measurement of crustal deformation in near real-time. The PGGA plays a unique role in studies of the kinematics of crustal deformation and the earthquake cycle in southern California because it is also providing temporally dense geodetic measurements of crustal motion over periods of minutes to variations in regional crustal strain. As it expands and matures the PGGA will play an increasingly important role in the study of active tectonics of southern California by bridging the frequency range between seismology, observatory geodesy, paleoseismology, and geology. In Indonesia GPS data is used for measurement of a large scale crustal deformation, extending from north China to the Indonesian archipelago. Indonesia offers a tremendous laboratory to study some of the processes that build continents, and mountains are active there. We began GPS observations in August 1989 on mainland Sumatra and the Mentawai Islands to study the phenomena of oblique plate convergence. We have analyzed the Indonesian data in conjunction with data collected on Christmas and Cocos Islands and at Darwin, Australia, and with the triangulation data in Sumatra.

Derived from text

N94-34026*# George Washington Univ., Washington, DC. Dept. of Electrical Engineering and Computer Science.

A STUDY OF NAVIGATION IN VIRTUAL SPACE

RUDY DARKEN, JOHN L. SIBERT, and RANDY SHUMAKER In NASA. Johnson Space Center, The Seventh Annual Workshop on Space Operations Applications and Research (SOAR 1993), Volume 1 p 51-60 Jan. 1994

(Contract N00014-91-K-2031) Avail: CASI HC A02/MF A04

In the physical world, man has developed efficient methods for navigation and orientation. These methods are dependent on the

high-fidelity stimuli presented by the environment. When placed in a virtual world which cannot offer stimuli of the same quality due to computing constraints and immature technology, tasks requiring the maintenance of position and orientation knowledge become laborious. In this paper, we present a representative set of techniques based on principles of navigation derived from real world analogs including human and avian navigation behavior and cartography. A preliminary classification of virtual worlds is presented based on the size of the world, the density of objects in the world, and the level of activity taking place in the world. We also summarize an informal study we performed to determine how the tools influenced the subjects' navigation strategies and behavior. We conclude that principles extracted from real world navigation aids such as maps can be seen to apply in virtual environments. Author

N94-34093# National Defence Research Establishment, Linköping (Sweden). Huvudavdelning för Informationsteknologi. **ALGORITHMS FOR A DIGITAL RADIO DIRECTION FINDING SYSTEM IN THE HF BAND**

T. B. JOHANSSON and H. T. JOHANSSON Dec. 1993 51 p (PB94-149176; FOA-C-30738-3.6) Avail: CASI HC A04/MF A01

The report presents an overview of methods for radio direction finding in the HF band, including phase difference to amplitude (Adcock) systems, interferometers, and pseudo-Doppler systems. Most of the work is concentrated on the Adcock technique which is to be included in an operational system under construction. Estimation algorithms to determine the angle of arrival for an eight-element Adcock array are described and improvements for the reduction of approximation errors are suggested. Furthermore, routines for time averaging the incoming data and calibration are presented to increase the system performance. Finally, results from simulations of the developed algorithms are given. NTIS

N94-34113# Technische Univ., Delft (Netherlands). Sectie Mathematische Geodesie en Puntbepaling.

DIFFERENTIAL GPS POSITIONING: DGPS MODELLING USING PSEUDO RANGE OBSERVATIONS

J. HUSSEM Aug. 1993 207 p See also PB93-221299 (PB94-149697) Avail: CASI HC A10/MF A03

Proper stochastic and functional modeling of pseudo ranges is essential for the use of quality control parameters. This thesis is concerned with the verification of the commonly used pseudo range stochastic and functional models. At five different baselines a large number of pseudo range observations has been performed. Some empirical results from these measurements are checked against their theoretical expectations. The following comparisons have been made: empirical positions/baselines against known positions/baselines; empirical and theoretical variances/covariances; empirical and theoretical distributions of positions, w-tests and F-tests; time correlation of pseudo range observations, positions and w-tests (modeling assumes no time correlation present). The measurements have been performed at five known baselines, ranging from 3 meters up to 200 km. The relation between baseline length and the above comparisons has been investigated. NTIS

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology

N94-32658 Lawrence Livermore National Lab., CA. **DUAL-BAND INFRARED IMAGING TO DETECT CORROSION DAMAGE WITHIN AIRFRAMES AND CONCRETE STRUCTURES**

N. K. DELGRANDE and P. F. DURBIN Jan. 1994 10 p Presented at the 16th SPIE Thermosense: International Conference on Ther-

mal Sensing and Imaging and Diagnostic Applications, Orlando, FL, 4-8 Apr. 1994 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract W-7405-ENG-48) (DE94-006047; UCRL-JC-115950; CONF-940483-1) Avail: CASI HC A02

We are developing dual-band infrared (DBIR) imaging and detection techniques to inspect air frames and concrete bridge decks for hidden corrosion damage. Using selective DBIR image ratios, we enhanced surface temperature contrast and removed surface emissivity noise associated with clutter. Our surface temperature maps depicted defect sites, which heat and cool at different rates than their surroundings. Our emissivity-ratio maps tagged and removed the masking effects of surface clutter. For airframe inspections, we used time-resolved DBIR temperature, emissivity-ratio, and composite thermal inertia maps to locate corrosion-thinning effects within a flash-heated Boeing 737 airframe. Emissivity-ratio maps tagged and removed clutter sites from uneven paint, dirt, and surface markers. Temperature and thermal inertia maps characterized defect sites, types, sizes, thicknesses, thermal properties and material-loss effects from air frame corrosion. For concrete inspections, we mapped DBIR temperature and emissivity-ratio patterns to better interpret surrogate delamination sites within naturally-heated, concrete slabs and remove the clutter mask from sand pile-up, grease stains, rocks, and other surface objects. DOE

N94-33056# Naval Postgraduate School, Monterey, CA.
DESIGN AND MONTE CARLO ANALYSIS OF AN UNMANNED AERIAL VEHICLE M.S. Thesis
JOSEPH P. FORDHAM Dec. 1993 88 p
(AD-A277648) Avail: CASI HC A05/MF A01

In the last several years, software innovations and the increasing speed and availability of microcomputers and workstations have made the dynamic simulation of complex systems more practical. One such system, a short-range Unmanned Aerial Vehicle called Bluebird, was previously modeled on Simulink, a commercial software package. The high fidelity model includes six degree of freedom nonlinear equations of motion with onboard sensors and a Global Positioning System and inertial navigation system. Because of interest expressed by the Unmanned Aerial Vehicle Joint Program Office in how accurately a UAV could identify a target's geographical coordinates, the Bluebird model, with an added guidance and control system, was evaluated as to its navigational and attitudinal accuracy in a dynamic simulation using Monte Carlo techniques. Because of the modular nature of the simulation, future evaluations of manned or unmanned aircraft and avionics will involve relatively uncomplicated changes to the existing model. DTIC

N94-33107 Wright Lab., Wright-Patterson AFB, OH.
RESPONSE OF A CANTILEVERED PLATE IN SUPERSONIC FLOW Interim Report, Jan. 1993 - Feb. 1994
MARK A. HOPKINS Feb. 1994 54 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract AF PROJ. 2401) (AD-A277487; WL-TM-94-3031) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The response of a thin rectangular panel to supersonic flow over its upper surface is investigated. The panel is fabricated of an isotropic material and has a constant thickness. The panel is fixed along one side such that the flow passes over its freely supported leading and trailing edges parallel to the fixed edge. A Rayleigh-Ritz method is applied to determine the in-plane and transverse response of the panel. The panel deflections either decay to a zero equilibrium or grow to a limited amplitude oscillation once the transients have decayed depending on the panel and flow parameters. At some combination of panel and flow parameters, the panel will begin to oscillate harmonically about a buckled state. Further increasing the flow conditions will cause the panel to either oscillate periodically about a buckled state or nonperiodically. The steady state response is dependent on the flow conditions and the initial

deflections and velocity profiles of the panel. The flow Mach number and panel length-to-width ratios were varied. The cantilevered panel response is compared to previous research. A simply supported panel is briefly discussed and its response is also compared to previous work. DTIC

N94-33329 RAND Corp., Santa Monica, CA.
THE NATIONAL AEROSPACE PLANE (NASP): DEVELOPMENT ISSUES FOR THE FOLLOW-ON VEHICLE
B. W. AUGENSTEIN and E. D. HARRIS 1993 47 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A278417; R-3878/1-AF; ISBN-0-8330-1842-4) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This executive summary presents the final results of a project Air Force study on development issues for follow on systems for the National Aerospace Plane (NASP). It provides an independent overview assessment of the NASP program, which is currently in phase 2 of a three-phase research, development, test, and evaluation (RDT&E) program. The project was to aid the NASP Joint Program Office (JPO) and others directly concerned with NASP in two major areas: to assist in efforts to define and validate the utility of potential missions in support of the phase 3 decision milestone and to conduct an integrated system overview of NASP and NASP-derived systems that considers enabling technologies, logistic support, military missions, economics, and political implications. CASI

N94-33448*# National Aeronautics and Space Administration, Washington, DC.
FIRST ANNUAL HSR PROGRAM WORKSHOP: HEADQUARTERS PERSPECTIVE
ROBERT E. ANDERSON In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 1 p 5-23 Apr. 1992
Avail: CASI HC A03/MF A04

The presentation is made up of viewgraphs. The national challenge is presented along with the program genesis and structure. The objectives of the workshop are also given. The national challenge is to develop and take advantage of the growing market for long distance air travel. The High Speed Civil Transport (HSCT) represents the next plateau in an aggressive international aviation competition. The workshop is to review and discuss future effort and plans in HSR. CASI

N94-33449*# Boeing Commercial Airplane Co., Seattle, WA.
NASA ANNUAL HSR WORKSHOP: BOEING HSCT PROGRAM SUMMARY
MICHAEL L. HENDERSON In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 1 p 27-92 Apr. 1992
Avail: CASI HC A04/MF A04

Boeing's view of the High Speed Civil Transport (HSCT) is given in viewgraph format. Boeing believes that the forecast for long range scheduled international traffic is sufficiently large in the post year 2005 time period to support a fleet of HSCT's. Technologies are projected to be available to create an HSCT that will have the required performance and operating economics, and which can be sold at a price that will provide a reasonable return to Boeing and the airlines. With relatively modest surcharges over competing subsonic fares, it is expected that an HSCT providing roughly a 50 percent time savings would capture a significant market share. CASI

N94-33450*# Douglas Aircraft Co., Inc., Saint Louis, MO.
Advanced Commercial Programs.
UPDATE ON DOUGLAS' HIGH-SPEED CIVIL TRANSPORT STUDIES
BRUCE L. BUNIN In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 1 p 95-133 Apr. 1992
Avail: CASI HC A04/MF A04

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

A summary is presented of high speed civil transport (HSCT) studies underway at Douglas Aircraft. A brief review is given of experience with design and development of advanced supersonic transport concepts and associated technology. A review is then presented of past NASA funded contract research studies focused on selection of appropriate concepts for high speed civil transport aircraft to be introduced in the year 2000 time frame for commercial service. Follow-on activities to those studies are then presented which were conducted under independent research studies as well as under further NASA funded efforts. Design Mach number selections and associated baseline design missions are then discussed along with forecasted passenger traffic and associated supersonic fleet sizes, and then proceeds into a discussion of individual issues related either to environmental acceptability or overall technology requirements in order to achieve the required economic viability of the program. A summary is given of current and future plans and activities.

Derived from text

N94-33452*# National Aeronautics and Space Administration, Washington, DC.

HEADQUARTERS SUMMARY REPORTS

In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 1 p 199-299 Apr. 1992

Avail: CASI HC A05/MF A04

The status is summarized of the NASA sponsored involvement in high speed civil transport research and technology, including major cooperative efforts. That involvement is currently focussed on the High Speed Research Program. The program goals are an acceptable level of ozone depletion or sonic boom, the definition of which is a regulatory and political process. The HSRP goal is to provide technical bases for acceptability criteria. Community noise is currently regulated, and it seems clear that HSCT aircraft will have to comply with at least the spirit of the current subsonic constraint, FAR 36, Stage 3.

CASI

N94-33453*# Boeing Commercial Airplane Co., Seattle, WA.

AIRFRAME SYSTEMS STUDIES REVIEW

FRANK D. NEUMANN In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 1 p 305-357 Apr. 1992

Avail: CASI HC A04/MF A04

The High Speed Civil Transport (HSCT) mission perspective is given, along with the systems studies goals, a configuration for the commercially viable HSCT, and a summary of the HSCT airframe systems studies during phases 1, 2, and 3. The environment effect goals are also presented, along with the airplane size projections, low sonic boom technology, and conclusions.

CASI

N94-33454*# Douglas Aircraft Co., Inc., Saint Louis, MO.

DOUGLAS AIRCRAFT HSCT STATUS AND FUTURE RESEARCH NEEDS

H. ROBERT WELGE In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 1 p 361-384 Apr. 1992

Avail: CASI HC A03/MF A04

Current activities on the High Speed Civil Transport (HSCT) at Douglas are focussed on baseline vehicle development at Mach 1.6 and 2.4. Parallel design activities incorporating the latest technologies in structures/materials, propulsion/noise, and aerodynamics are also being conducted and incorporated into the baseline to establish performance, economic viability, and environmental compliance. Studies are also being conducted to establish the feasibility of incorporating laminar flow control and minimized sonic boom concepts into the baseline. A decision point on these last two technologies is targeted prior to the start of the NASA HSR Phase 2 Program in 1993.

Derived from text

N94-33455*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

HIGH-SPEED RESEARCH PROGRAM SYSTEMS ANALYSIS ACTIVITIES AT AMES RESEARCH CENTER

GEORGE H. KIDWELL In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 1 p 387-419 Apr. 1992

Avail: CASI HC A03/MF A04

The Ames Systems Analysis Branch has been working to support the High Speed Research Program (HSRP) for nearly one year. Both the status of methodology development activities and the results of studies are presented whether completed or underway. The discussion involves the conceptual design synthesis program used for High Speed Civil Transport (HSCT) studies, ACSYNT (aircraft synthesis), and enhancements that have been made especially for HSRP. Some results are presented for one study that has been completed and two that are underway. These are the advanced controls integration study, the fuel cost impact study, and the oblique wing configuration evaluation that is part of a larger innovative concepts study.

Derived from text

N94-33456*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

OVERVIEW OF LANGLEY SYSTEMS STUDIES

SAMUEL D. DOLLYHIGH In its First Annual High-Speed Research Workshop, Part 1 p 423-455 Apr. 1992

Avail: CASI HC A03/MF A04

Late in 1990, the NASA Systems Integration Group began functioning and the aircraft systems studies entered a second phase. This group proposed tightly coordinated Ames/Langley/Lewis/industry studies that would address a series of tasks to evaluate progress, recommend appropriate direction, and emphasize changes in technology elements based on system level payoffs and potential success assessments. Based on technical and economic assessment studies of the High Speed Civil Transport (HSCT) to date, Mach 2.4 was chosen as the primary focus for the High Speed Research Program with Mach numbers 2.0 and 1.6 being backups in case of technology shortfalls. Langley has established an interdisciplinary team to strengthen the multidisciplinary aspects of aircraft design and analysis. The vehicle focus of this team is the HSCT. At Langley, early HSCT studies focused on turbojet powered aircraft. They also concluded that variable sweep wing concepts require 50/50 subsonic/supersonic to payoff for Mach 3.0 concept. Progress has been good in low sonic boom concepts.

CASI

N94-33471*# Boeing Commercial Airplane Co., Seattle, WA.

HSCT DESIGN FOR REDUCED SONIC BOOM

GEORGE T. HAGLUND In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 703-719 Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: low sonic boom design perspective; design approach for reduced sonic boom; target sonic boom waveforms; airplane design for reduced sonic boom loudness; design procedure for low sonic boom; wing design and nacelle lift effects; area distributions and F-functions due to volume; fuselage area distributions; low sonic boom design, configuration 3B; sonic boom characteristics; sizing, performance, and noise characteristics; a summary of phase 3 configurations; impact of sonic boom design constraints; and wing loading considerations.

Author

N94-33473*# Douglas Aircraft Co., Inc., Saint Louis, MO.

SONIC BOOM CONFIGURATION MINIMIZATION

ROBERT A. SOHN In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 741-756 Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: the sonic boom 'big picture'; current low boom technology; Mach number impact on gross weight; equal loudness equivalent areas; performance and sizing results; potential configuration modifications; equivalent area matching; and impact of nose bluntness on aerodynamic characteristics.

Author

N94-33504*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NACELLE-WING INTEGRATION

GELSOMINA CAPPUCIO In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1383-1399 Apr. 1992

Avail: CASI HC A03/MF A06

The Aerodynamics Division at NASA ARC is participating in the propulsion airframe integration phase of the High Speed Research Program. The two areas of research being pursued include an experimental program and analysis using computational fluid dynamics. The applied Aerodynamics Branch is conducting the experimental program, which will involve a nacelle airframe model that was tested in the Ames 11- by 11-Foot Transonic Wind Tunnel in 1973. This branch will also assess various Euler codes in predicting nacelle airframe interference effects. The goal is to provide the industry with the necessary data and tools to design a high speed civil transport with favorable propulsion airframe interference.

Author (revised)

N94-33505*# Boeing Commercial Airplane Co., Seattle, WA.

HSCT INLET DEVELOPMENT ISSUES

JOSEPH L. KONCSEK In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1403-1421 Apr. 1992

Avail: CASI HC A03/MF A06

The purpose of this presentation is to highlight the issues affecting the development of engine air inlets for the HSCT. The Propulsion Airframe Integration Technology (PAIT) contract sponsored by NASA LeRC is an important element in the evolution of the propulsion system that will eventually power the HSCT. Most of the material presented here is based on work performed by The Boeing Company under Task 1 and 2 of PAIT. From the propulsion perspective, the premier technology issues associated with the HSCT are airport noise and high altitude emissions. The sources are the nozzle and combustor, respectively. For the inlet the most challenging issues are associated with integration. Among the issues are the following: integration with the main landing gear—protection from FOD and water and slush ingestion from the runway; integration with the engine—ensuring engine/inlet airflow matching, normal shock stability during engine airflow transients, and keeping total pressure distortion within acceptable limits; integration with the wing—minimizing nacelle/wing interference drag and inlet flowfield velocity distortion.

Author (revised)

N94-33506*# Douglas Aircraft Co., Inc., Long Beach, CA.

STATUS OF AN INLET CONFIGURATION TRADE STUDY FOR THE DOUGLAS HSCT

JAY R. JONES and H. ROBERT WELGE In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1425-1436 Apr. 1992

Avail: CASI HC A03/MF A06

An inlet concept integration trade study for an HSCT is being conducted under contract to NASA LeRC. The HSCT mission has a supersonic cruise Mach number of 2.4 and a subsonic cruise Mach number of 0.95. The engine selected for this study is the GE VCE (variable cycle engine) with FLADE (fan on blade). Six inlet configurations will be defined. Inlet configurations will be axisymmetric and rectangular mixed-compression inlets in single-engine nacelles. Airplane performance for each inlet configuration will be estimated and then compared. The most appropriate inlet configuration for this airplane/engine combination will be determined by Sep. 1991.

Author (revised)

N94-33508*# Lockheed Engineering and Sciences Co., Hampton, VA.

RESULTS OF A PRELIMINARY INVESTIGATION OF INLET UNSTART ON A HIGH-SPEED CIVIL TRANSPORT AIRPLANE CONCEPT

CHRISTOPHER S. DOMACK In NASA. Langley Research Center,

First Annual High-Speed Research Workshop, Part 3 p 1463-1479 Apr. 1992

Avail: CASI HC A03/MF A06

The aircraft design engineer of today is tasked with satisfying an increasing number of conflicting requirements. The fact that conflict in these requirements may be technically, economically, or politically motivated usually compounds the difficulty of determining the best solution to a design issue. In this regard, propulsion/airframe integration for supersonic airplanes must rank as one of the most challenging aspects of airplane design. For the cruise Mach numbers currently being considered for High-Speed Civil Transport (HSCT) airplanes, the inlet requirements of low drag, low bleed flow, and high pressure recovery appear to be best met with a mixed-compression design. Unfortunately, these desirable attributes come with a highly undesirable companion: the inlet unstart phenomenon. Concern over the effects of a mixed-compression inlet unstart on the vehicle dynamics of large, high-speed aircraft is not new; a comprehensive wind-tunnel study addressing the problem was published in 1962. Additional investigations of the problem were made throughout the United States SST program and the follow-on NASA program into the late 1970's. The current study sought to examine the magnitude of the problem in order to determine if an inlet unstart posed a potential hazard severe enough to preclude the use of mixed-compression inlets on proposed HSCT concepts.

Author (revised)

N94-33509*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

STATUS OF THE VARIABLE DIAMETER CENTERBODY INLET PROGRAM

JOHN D. SAUNDERS and A. A. LINNE In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1483-1504 Apr. 1992

Avail: CASI HC A03/MF A06

The Variable Diameter Centerbody (VDC) inlet is an ongoing research program at LeRC. The VDC inlet is a mixed compression, axisymmetric inlet that has potential application on the next generation supersonic transport. This inlet was identified as one of the most promising axisymmetric concepts for supersonic cruise aircraft during the SCAR program in the late 1970's. Some of its features include high recovery, low bleed, good angle-of-attack tolerance, and excellent engine airflow matching. These features were demonstrated at LeRC in the past by the design and testing of fixed hardware models. A current test program in the LeRC 10' x 10' Supersonic Wind Tunnel (SWT) will attempt to duplicate these features on model hardware that actually incorporates a flight-like variable diameter centerbody mechanism.

Author (revised)

N94-33536*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EFFECTIVE DECLUTTER OF COMPLEX FLIGHT DISPLAYS USING STEREOPTIC 3-D CUEING

RUSSELL V. PARRISH, STEVEN P. WILLIAMS, and DEAN E. NOLD Apr. 1994 25 p

(Contract RTOP 505-64-53-03; DA PROJ. 1L1-62211-AH-85) (NASA-TP-3426; L-17308; NAS 1.60:3426; CECOM-TR-93-B-E-3)

Avail: CASI HC A03/MF A01

The application of stereo technology to new, integrated pictorial display formats has been effective in situational awareness enhancements, and stereo has been postulated to be effective for the declutter of complex informational displays. This paper reports a full-factorial workstation experiment performed to verify the potential benefits of stereo cueing for the declutter function in a simulated tracking task. The experimental symbology was designed similar to that of a conventional flight director, although the format was an intentionally confused presentation that resulted in a very cluttered dynamic display. The subject's task was to use a hand controller to keep a tracking symbol, an 'X', on top of a target symbol, another X, which was being randomly driven. In the basic tracking task, both the target symbol and the tracking symbol were presented as red X's.

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The presence of color coding was used to provide some declutter, thus making the task more reasonable to perform. For this condition, the target symbol was coded red, and the tracking symbol was coded blue. Noise conditions, or additional clutter, were provided by the inclusion of randomly moving, differently colored X symbols. Stereo depth, which was hypothesized to declutter the display, was utilized by placing any noise in a plane in front of the display monitor, the tracking symbol at screen depth, and the target symbol behind the screen. The results from analyzing the performances of eight subjects revealed that the stereo presentation effectively offsets the cluttering effects of both the noise and the absence of color coding. The potential of stereo cueing to declutter complex informational displays has therefore been verified; this ability to declutter is an additional benefit from the application of stereoptic cueing to pictorial flight displays. Author

N94-33565* National Aeronautics and Space Administration, Washington, DC.

PERSEUS: GLOBAL WATCHER (Videotape)

1993 Videotape: 7 min. playing time, in color, with sound (NASA-TM-109813; NONP-VT-94-12941) Avail: CASI VHS A01/BETA A22

This video documents efforts of NASA Dryden Flight Research Center to develop and utilize ultra-light, remotely piloted gliders to study Earth's atmosphere. The advantage of these vehicles is that they are inexpensive, and can fly at altitudes twice that of commercial airlines. CASI

N94-33790* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH.

STOVL (Videotape)

Jan. 1990 Videotape: 4 min. 43 sec. playing time, in color, with sound

(NASA-TM-109845; REPT-4003; NONP-VT-94-13535) Avail: CASI VHS A01/BETA A22

This video examines research and applications of the STOVL aircraft. CASI

N94-33875# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.

OPERATIONAL AGILITY [LA MANIABILITE OPERATIONNELLE]

Apr. 1994 222 p

(AGARD-AR-314; ISBN-92-835-0743-6) Copyright Avail: CASI HC A10/MF A03

From previous AGARD activities, it was recognized that flying qualities and traditional aircraft performance parameters did not characterize the capability or effectiveness of combat aircraft, although they do offer a guide. Other expert groups had reached a similar conclusion. The subject that arose from these realizations was 'agility'. Recognizing that this was an incomplete or immature concept and that a wide variety of sometimes disparate views existed, the Flight Mechanics Panel formed a further Working Group, WG 19, consisting of specialists from AGARD member countries, to study the subject under the title of 'Operational Agility'. Working sessions were held at places of special interest to the group, between 1991 and 1993. The specific aims of the Working Group were to provide definitions, which are universally acceptable, of the terminologies involved in agility; to collate the results of lessons learned from experiments on agility; to define metrics or figures of merit for use in design and evaluation; to explore and document the theoretical foundations; to explore the operational pay-off of balanced capabilities between the airframe, systems and weapons; to highlight any specialized aspects applicable to rotorcraft; to indicate possible means of evaluation in flight; and to recommend areas for further research and development activities, including possible collaborative projects. The Group has completed its study of operational agility with this report. In undertaking the study, a greater understanding has been reached of those subjects which influence operational agility and how these subjects, via the

use of operational agility concepts, may be related to the combat effectiveness of the weapon systems. In reaching this understanding, the Group has proposed definitions of the agility terminology which should prove universally acceptable; it has arrived at the methodology for assessment of the various component systems which contribute to the operational agility or combat effectiveness of a Weapon System; and has listed a number of major conclusions and recommendations. Author

N94-33900*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

MULTILEVEL DECOMPOSITION APPROACH TO INTEGRATED AERODYNAMIC/DYNAMIC/STRUCTURAL OPTIMIZATION OF HELICOPTER ROTOR BLADES

JOANNE L. WALSH, KATHERINE C. YOUNG, JOCELYN I. PRITCHARD, HOWARD M. ADELMAN, and WAYNE R. MANTAY May 1994 26 p Presented at the AHS Aeromechanics Specialists Conference, San Francisco, CA, 19-21 Jan. 1994

(Contract RTOP 505-63-36-06)

(NASA-TM-109084; NAS 1.15:109084; ARL-TR-476) Avail: CASI HC A03/MF A01

This paper describes an integrated aerodynamic, dynamic, and structural (IADS) optimization procedure for helicopter rotor blades. The procedure combines performance, dynamics, and structural analyses with a general purpose optimizer using multilevel decomposition techniques. At the upper level, the structure is defined in terms of local quantities (stiffnesses, mass, and average strains). At the lower level, the structure is defined in terms of local quantities (detailed dimensions of the blade structure and stresses). The IADS procedure provides an optimization technique that is compatible with industrial design practices in which the aerodynamic and dynamic design is performed at a global level and the structural design is carried out at a detailed level with considerable dialogue and compromise among the aerodynamic, dynamic, and structural groups. The IADS procedure is demonstrated for several cases. Author

N94-34080 Army Aeromedical Research Lab., Fort Rucker, AL. **PERFORMANCE DEMONSTRATION: UH-60Q EXTERNAL RESCUE HOIST AND CARGO LOADMETER**

JAMES E. BRUCKART and JOSEPH R. LICINA Jan. 1994 21 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A277533; USAARL-94-6) Avail: CASI HC A03

The UH-60Q prototype MEDEVAC Black Hawk is configured to provide day/night, adverse weather, emergency movement of patients. The objective of this report is to describe the results of capability demonstrations for operating the external rescue hoist and cargo hook. The external rescue hoist is electrically operated and includes a digital indication of the cable payout. Hoist operations were accomplished with manikins in Stokes and Skedco litters. External cargo loading operations were completed lifting a 1200-lb external load. External hoist and cargo load operations can be completed in the prototype aircraft with a typical MEDEVAC Black Hawk crew. The hoist operator is not able to operate the hoist from the crew seat. He has to push the litter clear of the aircraft tire and pull the weight of the litter aft to load it into the aircraft. The external cargo loading procedures essentially are unchanged with the addition of the cargo loadmeter. The aircraft crew stated that the loadmeter provided valuable information on the status of the external load. DTIC

N94-34118*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

VEHICLE INTEGRATION EFFECTS ON HYPERSONIC WAVERIDERS M.S. Thesis - George Washington Univ.

CHARLES EDWARD COCKRELL, JR. 21 Apr. 1994 132 p (NASA-TM-109739; NAS 1.15:109739) Avail: CASI HC A07/MF A02

The integration of a class of hypersonic high-lift configurations

known as waveriders into hypersonic cruise vehicles was evaluated. Waveriders offer advantages in aerodynamic performance and propulsion/airframe integration (PAI) characteristics over conventional hypersonic shapes. A wind-tunnel model was developed which integrates realistic vehicle components with two waverider shapes, referred to as the 'straight-wing' and 'cranked-wing' shapes. Both shapes were conical-flow-derived waveriders at a design Mach number of 4.0. The cranked-wing shape was designed to provide advantages in subsonic performance and directional stability over conventional waveriders. Experimental data and limited computational fluid dynamics (CFD) predictions were obtained over a Mach number range of 2.3 to 4.63 at a Reynolds number of 2.0×10^6 (exp 6) per foot. The CFD predictions and flow visualization data confirmed the shock attachment characteristics of the baseline waverider shapes and illustrated the waverider flow-field properties. Both CFD predictions and experimental data showed that no significant performance degradations occur at off-design Mach numbers for the waverider shapes and the integrated configurations. The experimental data showed that the effects of adding a realistic canopy were minimal. The effects of adding engine components were to increase the drag and thus degrade the aerodynamic performance of the configuration. A significant degradation in aerodynamic performance was observed when 0 degree control surfaces were added to close the blunt base of the waverider to a sharp trailing edge. A comparison of the fully-integrated waverider models to the baseline shapes showed that the performance was significantly degraded when all of the components were added to the waveriders. The fully-integrated configurations studied here do not offer significant performance advantages over conventional hypersonic vehicles, but still offer advantages in air-breathing propulsion integration. Additionally, areas are identified in this study where improvements could be made to enhance the performance. Both fully-integrated configurations are longitudinally unstable over the Mach number range studied for unpowered conditions. The cranked-wing fully-integrated configuration provided significantly better lateral-directional stability characteristics than the straight-wing configuration.

Author

N94-34128 National Defence Research Establishment, Stockholm (Sweden). Dept. of Weapon Systems, Effects and Protection.

INSTALLATION OF AN FTIR SPECTROMETER IN THE TP86 SABRELINER [INSTALLATION AV FTIR-SPEKTROMETER I TP86 SABRELINER]

C. NELSSON Sep. 1993 25 p In SWEDISH (PB94-149036; FOA-A-30086-8.3.3.1) Avail: Issuing Activity (National Technical Information Service (NTIS))

To be able to spectrally determine the IR signature of aircraft and flares under realistic conditions an FTIR spectrometer has been installed in a TP86 Sabreliner at FMV. The report contains a description of the installation and of the preparation work with a focus on the equipment from FOA. The measurement procedure and experiences from FOA's point of view are also included. NTIS

N94-34356# Nanjing Aeronautical Inst. (China). Test and Measurement Centre.

THE MEASUREMENT AND THREE DIMENSIONAL RECONSTRUCTION FOR CONFIGURATION OF AIR VEHICLE USING IMAGE PROCESSING TECHNIQUES

YING-EN XIONG, XIN QIAO, and DE-ZONG WANG In its Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 216-219 1993

Avail: CASI HC A01/MF A03

A new method of the measurement and three dimensional reconstruction for air vehicle configuration using image processing techniques is presented. Two parts are included in this method. The first part included following. Two or more photographs are taken using ordinary camera. These photographs are inputted in digital image processing system. After some necessary processing, the coordinates of suitable points for every image are achieved and the three dimensional information is gained. According to this three dimensional information, the three dimensional coordinates of the

configuration of air vehicle are solved. The second part includes following. More coordinates of points of the air vehicle configuration are solved by mathematical method using the points gained above. The grid drawing of the air vehicle configuration is achieved by fitting these points. At last, the three dimensional stereo image of the air vehicle configuration is set up by using the surface information of air vehicle and certain lighting conditions. So, the reconstruction for air vehicle configuration is reached. Through practical application, it is expressed that the air vehicle configuration can be obtained using this method. The computer program system made up in this paper has many advantages. It can be applied not only for the measurement and three dimensional reconstruction of air vehicle configuration, but also for other objects. It has practical applications for aeronautics, astronautics, computer vision, and intelligent system.

Author

N94-34433# Rolls-Royce Ltd., Bristol (England).

HELICOPTER ENGINE/AIRFRAME INTEGRATION: THE WAY AHEAD

D. L. MANN and D. V. HUMPHERSON In AGARD, Technology Requirements for Small Gas Turbines 12 p Mar. 1994 Sponsored in part by Ministry of Defence

Copyright Avail: CASI HC A03/MF A04

The importance of successful integration of a turboshaft engine into the recipient helicopter becomes ever more apparent as the market demands a product which is able to carry more payload, over greater distances, in a reduced time, with greater reliability, and at lower cost. New technology developments in individual vehicle systems alone will not be sufficient to ensure future competitiveness. Engine/airframe integration has a significant, previously neglected, role to play. Important direct performance improvements may potentially be exceeded by synergistic, spin-off benefits to other components. In some areas, such as stealth, adequate consideration of integration matters is becoming mandatory. The paper reviews some helicopter component technology directions and observes the implications of harnessing these technologies into integrated systems. Particular attention is paid to integrated intake and exhaust system designs as well as a more general look at overall vehicle integration. A final section discusses integration technology requirements and how they may be employed to produce a fully integrated airframe and engine design philosophy. Author

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AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

N94-32457*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

MICROWAVE SENSOR FOR ICE DETECTION

G. D. ARNDT, A. CHU, L. G. STOLARCZYK, and G. L. STOLARCZYK In NASA, Washington, Technology 2003: The Fourth National Technology Transfer Conference and Exposition, Volume 2 p 318-325 Feb. 1994

Avail: CASI HC A02/MF A04

A microwave technique has been developed for detecting ice build-up on the wing surfaces of commercial airliners and highway bridges. A microstrip patch antenna serves as the sensor, with changes in the resonant frequency and impedance being dependent upon the overlying layers of ice, water and glycol mixtures. The antenna sensor is conformably mounted on the wing. The depth and dielectric constants of the layers are measured by comparing the complex resonant admittance with a calibrated standard. An initial breadboard unit has been built and tested. Additional development is now underway. Another commercial application is in the robotics field of remote sensing of coal seam thickness. Author

N94-32909# Wright Lab., Wright-Patterson AFB, OH.

A FRAMEWORK FOR DEVELOPING AND MANAGING

REUSABLE AVIONICS SOFTWARE Final Report, 1 May - 1 Sep. 1993

RAGHAVA G. GOWDA Sep. 1993 24 p

(Contract AF PROJ. 9994)

(AD-A276846; WL-TR-94-1033) Avail: CASI HC A03/MF A01

Developing reusable software for avionics systems is a challenge to software engineers. The task involves foreseeing future applications, modeling real-world events, using appropriate CASE tools throughout the development life cycle, and providing for storage and retrieval of reusable software components. This report presents a model for developing and managing reusable software components, briefly describes the software process maturity model and the integration of CASE tools with the process maturity model. It also identifies tools/techniques and methodologies for real-time systems development, examines the critical issues in managing software projects, and offers the management a set of guidelines to introduce software engineering methodologies and CASE tools within the organization through a model project which may enforce standards for new projects. Author

N94-33076# Federal Aviation Administration, Washington, DC. Synthetic Vision Program Office.

SYNTHETIC VISION TECHNOLOGY DEMONSTRATION. VOLUME 1: EXECUTIVE SUMMARY Final Report

MALCOLM A. BURGESS, TERENCE CHANG, DALE E. DUNFORD, ROGER H. HOH, WALTER F. HORNE, and RICHARD F. TUCKER Dec. 1993 111 p

(DOT/FAA/RD-93/40-VOL-1) Avail: CASI HC A06/MF A02

This report contains the description and results of a Synthetic Vision technology demonstration program conducted jointly by the Federal Aviation Administration, the Department of Defense and industry. The relevant technologies including millimeter wave radar sensors, infrared sensors, head-up displays, and computer processing were developed and tested in static tower tests and in flight tests in which the weather conditions were carefully measured and documented. The purpose of the program was to evaluate and demonstrate the performance of the imaging sensors and of the complete imaging system during aircraft approaches and landings in low-visibility conditions. The static tower test facility used was the Avionics Tower Test Facility, located at Wright Patterson AFB, in which candidate sensors were set up at approximately 260 feet overlooking a nearby runway. The runway scene imaged by the sensors was instrumented to carefully measure the characteristics of fog, rain and snow as those conditions occurred in 1991-1992. Sensor performance and phenomenology was then fully characterized to provide a basis for further sensor development and for selection of sensors with which to proceed to flight test. The test aircraft used was a Gulfstream II configured with a comprehensive data collection system and instrumentation to permit measurement of fog and precipitation through which the aircraft was flown as well as system and pilot performance during those operations. Millimeter wave sensors and an infrared sensor were used to provide an electronic image of the runway on both head-up and head-down displays during approach, landing and takeoff. Test and demonstration flights were flown into 27 different airports in a wide variety of rain, fog and snow conditions during the period of May through December, 1992. This first volume is an executive summary containing an overview of the work from a management perspective. Author

N94-33077# Federal Aviation Administration, Washington, DC. Synthetic Vision Program Office.

SYNTHETIC VISION TECHNOLOGY DEMONSTRATION. VOLUME 2: SENSOR TOWER TESTING Final Report

BRIAN H. HUDSON (Georgia Tech Research Inst., Atlanta.), MOLLY J. GARY (Georgia Tech Research Inst., Atlanta.), MALCOLM A. BURGESS, and J. ALLEN ZAK Dec. 1993 293 p

(DOT/FAA/RD-93/40-VOL-2) Avail: CASI HC A13/MF A03

This report contains the description and results of a Synthetic Vision technology demonstration program conducted jointly by the

Federal Aviation Administration, the Department of Defense and industry. The relevant technologies including millimeter wave radar sensors, infrared sensors, head-up displays, and computer processing were developed and tested in static tower tests and in flight tests in which the weather conditions were carefully measured and documented. The purpose of the program was to evaluate and demonstrate the performance of the imaging sensors and of the complete imaging system during aircraft approaches and landings in low-visibility conditions. The static tower test facility used was the Avionics Tower Test Facility, located at Wright Patterson AFB, in which candidate sensors were set up at approximately 260 feet overlooking a nearby runway. The runway scene imaged by the sensors was instrumented to carefully measure the characteristics of fog, rain and snow as those conditions occurred in 1991-1992. Sensor performance and phenomenology was then fully characterized to provide a basis for further sensor development and for selection of sensors with which to proceed to flight test. The test aircraft used was a Gulfstream II configured with a comprehensive data collection system and instrumentation to permit measurement of fog and precipitation through which the aircraft was flown as well as system and pilot performance during those operations. Millimeter wave sensors and an infrared sensor were used to provide an electronic image of the runway on both head-up and head-down displays during approach, landing and takeoff. Test and demonstration flights were flown into 27 different airports in a wide variety of rain, fog and snow conditions during the period of May through December, 1992. This is volume 2 of a four volume final report on the Synthetic Vision Technology Demonstration Program. This volume documents the tower tests performed in the program. Author (revised)

N94-33078# Federal Aviation Administration, Washington, DC. Synthetic Vision Program Office.

SYNTHETIC VISION TECHNOLOGY DEMONSTRATION. VOLUME 3: FLIGHT TESTS Final Report

MALCOLM A. BURGESS, TERENCE CHANG, DALE E. DUNFORD, ROGER H. HOH, WALTER F. HORNE, RICHARD F. TUCKER, and J. ALLEN ZAK Dec. 1993 398 p

(DOT/FAA/RD-93/40-VOL-3) Avail: CASI HC A17/MF A04

This report contains the description and results of a Synthetic Vision technology demonstration program conducted jointly by the Federal Aviation Administration, the Department of Defense and industry. The relevant technologies including millimeter wave radar sensors, infrared sensors, head-up displays, and computer processing were developed and tested in static tower tests and in flight tests in which the weather conditions were carefully measured and documented. The purpose of the program was to evaluate and demonstrate the performance of the imaging sensors and of the complete imaging system during aircraft approaches and landings in low-visibility conditions. The static tower test facility used was the Avionics Tower Test Facility, located at Wright Patterson AFB, in which candidate sensors were set up at approximately 260 feet overlooking a nearby runway. The runway scene imaged by the sensors was instrumented to carefully measure the characteristics of fog, rain and snow as those conditions occurred in 1991-1992. Sensor performance and phenomenology was then fully characterized to provide a basis for further sensor development and for selection of sensors with which to proceed to flight test. The test aircraft used was a Gulfstream II configured with a comprehensive data collection system and instrumentation to permit measurement of fog and precipitation through which the aircraft was flown as well as system and pilot performance during those operations. Millimeter wave sensors and an infrared sensor were used to provide an electronic image of the runway on both head-up and head-down displays during approach, landing and takeoff. Test and demonstration flights were flown into 27 different airports in a wide variety of rain, fog and snow conditions during the period of May through December, 1992. This is the third of four volumes and it documents the flight tests performed in the program, incorporating reports from all of the participants. Author (revised)

N94-33079# Federal Aviation Administration, Washington, DC. Synthetic Vision Program Office.

SYNTHETIC VISION TECHNOLOGY DEMONSTRATION. VOLUME 4: APPENDICES Final Report

MALCOLM A. BURGESS, TERENCE CHANG, DALE E. DUNFORD, ROGER H. HOH, WALTER F. HORNE, RICHARD F. TUCKER, and BRIAN H. HUDSON Dec. 1993 317 p (DOT/FAA/RD-93/40-VOL-4) Avail: CASI HC A14/MF A03

This report contains the description and results of a Synthetic Vision technology demonstration program conducted jointly by the Federal Aviation Administration, the Department of Defense and industry. The relevant technologies including millimeter wave radar sensors, infrared sensors, head-up displays, and computer processing were developed and tested in static tower tests and in flight tests in which the weather conditions were carefully measured and documented. The purpose of the program was to evaluate and demonstrate the performance of the imaging sensors and of the complete imaging system during aircraft approaches and landings in low-visibility conditions. The static tower test facility used was the Avionics Tower Test Facility, located at Wright Patterson AFB, in which candidate sensors were set up at approximately 260 feet overlooking a nearby runway. The runway scene imaged by the sensors was instrumented to carefully measure the characteristics of fog, rain and snow as those conditions occurred in 1991-1992. Sensor performance and phenomenology was then fully characterized to provide a basis for further sensor development and for selection of sensors with which to proceed to flight test. The test aircraft used was a Gulfstream II configured with a comprehensive data collection system and instrumentation to permit measurement of fog and precipitation through which the aircraft was flown as well as system and pilot performance during those operations. Millimeter wave sensors and an infrared sensor were used to provide an electronic image of the runway on both head-up and head-down displays during approach, landing and takeoff. Test and demonstration flights were flown into 27 different airports in a wide variety of rain, fog and snow conditions during the period of May through December, 1992. This is the final volume of the report. It is a compilation of appendices containing additional detail pertaining to the flight tests. Author (revised)

N94-33280# Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

COCKPIT ELECTRONIC DISPLAY WORKSHOP: A SYNOPSIS Final Report, Apr. - Oct. 1993

M. S. HUNTLEY, JR. and ROWENA MORRISON Dec. 1993 25 p Workshop held in Cambridge, MA, 7-9 Apr. 1993 (AD-A277728; DOT-VNTSC-FAA-93-21; DOT/FAA/RD-93/42) Avail: CASI HC A03/MF A01

Thirty-six government, academic, and industry human factors professionals participated in a workshop convened at the Volpe National Transportation Systems Center to identify human factors issues associated with depicting terminal area operations information on electronic cockpit displays. Two working groups, formed from the meeting attendees, identified a variety of research issues associated with the identification, distribution, and electronic presentation of terminal area information to flight crews. This document presents a summary of the proceedings produced by that meeting and an edited list of research issues derived from those proceedings. The summary document also includes two disks containing the original workshop proceedings. These disks were formatted in Microsoft Word 5.1 for Macintosh. Please refer to the Read me file for further instructions. DTIC

N94-33409# Systems and Electronics, Inc., Elk Grove Village, IL. DESIGN, MANUFACTURE, AND TEST OF A FLIGHT LOAD RECORDER FOR SMALL AIRCRAFT Technical Note, Nov. 1992 - May 1993

C. OLKIEWICZ, J. MOHAMMADI, and J. CICERO Feb. 1994 27 p (Contract DTRS57-92-C-00093)

(AD-A277752; SEI-249-93-03; DOT/FAA/CT-TN93/23) Avail: CASI HC A03/MF A01

This technical note covers phase 1 of a research and development effort to design, manufacture, and test a lightweight, low cost, flight load data recording system for small aircraft. The system design description (including hardware, firmware, and software), installation details, battery pack, and support brackets are presented. Discussions of the flight parameters, recording requirements of commercial aircraft, sensors needed to accommodate the flight parameters, data acquisition, and installation requirements of the sensors aboard the aircraft are covered. The research and development in Phase 2 including the environmental and vibration tests and production of the system for full implementation by the commercial aviation industry are also presented. DTIC

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

N94-32859*# United Technologies Corp., Windsor Locks, CT. IN FLIGHT MEASUREMENT OF STEADY AND UNSTEADY BLADE SURFACE PRESSURE OF A SINGLE ROTATION LARGE SCALE ADVANCED PROP-FAN INSTALLED ON THE PTA AIRCRAFT Final Report

D. PARZYCH, L. BOYD, W. MEISSNER, and A. WYROSTEK Sep. 1991 188 p Original contains color illustrations (Contract NAS3-23051; RTOP 535-03-10) (NASA-CR-187096; NAS 1.26:187096) Avail: CASI HC A09/MF A02; 42 functional color pages

An experiment was performed by Hamilton Standard, Division of United Technologies Corporation, under contract by LeRC, to measure the blade surface pressure of a large scale, 8 blade model prop-fan in flight. The test bed was the Gulfstream 2 Prop-Fan Test Assessment (PTA) aircraft. The objective of the test was to measure the steady and periodic blade surface pressure resulting from three different Prop-Fan air inflow angles at various takeoff and cruise conditions. The inflow angles were obtained by varying the nacelle tilt angles, which ranged from -3 to +2 degrees. A range of power loadings, tip speeds, and altitudes were tested at each nacelle tilt angle over the flight Mach number range of 0.30 to 0.80. Unsteady blade pressure data tabulated as Fourier coefficients for the first 35 harmonics of shaft rotational frequency and the steady (non-varying) pressure component are presented. Author

N94-33035*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

INLET DISTORTION IN ENGINES ON VSTOL AIRCRAFT Final Technical Report, Oct. 1989 - Dec. 1993

CHOON S. TAN and EDWARD M. GREITZER May 1994 61 p (Contract NAG3-1567) (NASA-CR-195841; NAS 1.26:195841) Avail: CASI HC A04/MF A01

This report presents the results of a research program on inlet distortion in engines on VSTOL aircraft carried out at the MIT Gas Turbine Laboratory during the period Oct. 1989 - Dec. 1993. The program focused on the development of three dimensional flow computational methodology for predicting the effects of nonuniform flow on the performance of aircraft engines in VSTOL aircraft, the development of a three dimensional instability analysis of flow in multistage axial compressors, and the preliminary applications of these newly developed methodologies for elucidating the effects of flow three dimensionality. The accomplishments of the program are brought out when the current status of predictive capabilities for three dimensional flow instabilities in compressors is assessed against that in 1989. Author (revised)

07 AIRCRAFT PROPULSION AND POWER

N94-33266 Naval Postgraduate School, Monterey, CA.
A USER'S MANUAL FOR THE COST EFFECTIVENESS ANALYSIS SPREADSHEET MODEL FOR AIRCRAFT ENGINES (CEAMOD VERSION 2.0) M.S. Thesis
ROSS R. REEVES Dec. 1993 364 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A278042) Avail: CASI HC A16

This thesis provides a comprehensive procedures manual and user's guide which will enable both current users and beginners to understand and employ Version 2.0 of the Cost Effectiveness Analysis model (CEAMOD), which is written in EXCEL spreadsheet software, in their service's aircraft engine Component Improvement Programs (CIP). The purpose of the CEAMOD is to project the possible savings which would be achieved from an Engineering Change Proposal's (ECP) implementation. The thesis begins by describing the model's background, basic assumptions, and format. Next, a detailed description of each page and the cell formulas used in each column of the spreadsheet are provided. A 'getting started' user's guide was also created to provide the user with the basic information necessary to actually use the CEA Deck/EXCEL spreadsheet software. An example of each page of the CEA model is provided as well as the Standard History File fleet input pages.

DTIC

N94-33283 Naval Postgraduate School, Monterey, CA.
ANALYSIS OF INTERMEDIATE LEVEL MAINTENANCE FOLLOWING F404-GE-400 ENGINE COMPONENT LIFE REDUCTIONS M.S. Thesis
JERI S. KING and WILLIAM M. TOOKER Dec. 1993 85 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A277918) Avail: CASI HC A05

This thesis is an analysis of the effect that component life limit reductions of the F404-GE-400 engine have on AIMD Lemoore Power Plants Division operations. Estimations of fleet impact due to F404 component life limit reductions did not include the affect on production work centers. This thesis used simulation modeling of the F404 engine repair process at AIMD Lemoore to investigate the impact of these reductions. The simulation model outcomes provide strong indications that AIMD Power Plants Division operations will not be substantially altered by F404 component life limit reductions. However, there will be a significant impact on engine turn around time and the number of aircraft grounded awaiting engines. Recommendations to reduce the impact of component life limit reductions include improved logistical support in long-lead repair items. Additionally, the researchers recommend greater use of simulation modeling in future planning and analysis of significant logistics support changes.

DTIC

N94-33339 Canadian Forces Base Trenton, Astra (Ontario).
AN EXPERT SYSTEM APPLICATION FOR TROUBLESHOOTING THE CF18 F404 ENGINE
W. D. E. ALLAN and R. C. BEST In Royal Military Coll. of Canada, Proceedings of the Symposium/Workshop on Applications of Expert Systems in DND p 93-101 Apr. 1992
Avail: Issuing Activity (Royal Military Coll. of Canada, Vimy Post Office, Kingston, ON K7K 5L0 Canada)

Troubleshooting the CF-18 F404 engine often involves referring to data recorded by the Inflight Engine Condition Monitoring System (IECMS), which routinely records engine and aircraft parameters during flight. A software suite has been developed for graphically presenting these data. Troubleshooting procedures have been amended to include the analysis of the plots, focusing on features unique to known faults. An expert system application is proposed to provide assistance to technicians in utilizing this information in the troubleshooting process. The ability of the system to recognize the fault signatures and to be readily updated with new patterns will be central to the success of the proposed application. The role of the system in supporting second and third line maintenance activities is also discussed. An overriding consideration in the application of

expert system technology to the maintenance of the F404 engine is the necessity to maintain the level of expertise of the technicians. The system will provide recommendations for solutions, but final maintenance decisions must always rest with the technician.

Author (CISTI)

N94-33365 Cincinnati Univ., OH.
LASER MEASUREMENTS AND ANALYSIS OF FLOW IN A RADIAL INFLOW TURBINE INLET GUIDE VANES AND ROTOR Ph.D. Thesis
MERIH PASIN 1993 235 p
Avail: Univ. Microfilms Order No. DA9319264

Detailed measurements of an unsteady flow field within the inlet guide vanes (IGV) and the rotor of a radial inflow turbine were performed using a three component laser Doppler velocimeter (LDV) system together with a rotary encoder. The mean velocity, flow angle, and the turbulence contours for IGV passages are presented at four blade-to-blade planes for different rotor positions. These results are compared with the measurements obtained in the same passage in the absence of the rotor. The flow field of the IGV passage was found to be affected by the presence of the rotor. The ratio of the tangential normal stresses to the radial normal stresses at the exit of the IGV was found to be more than doubled when compared to the case without the rotor. The rotor flow field measurements are presented in the relative mean velocity and turbulence stress contour at various cross section planes throughout the rotor. The cross flow and turbulence stress levels were found to be influenced by the presence of the incidence angle. Transportation of the high turbulence fluid by the cross flow was observed in the rotor blade passages. The panel code was run for both the IGV and the rotor geometries, and results were compared with the experimental time averaged velocity results at midspan.

Dissert. Abstr.

N94-33443 Federal Aviation Administration, Atlantic City, NJ.
AIRCRAFT HIGH BYPASS FAN ENGINE PERFORMANCE
ROBERT SALMON Mar. 1994 24 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A277722; DOT/FAA/CT-TN92/35) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of this technical note is to discuss the performance characteristics of high bypass fan engines. The performance of a CF6-6 type fan engine is compared to two types of modified engines based on the CF6-6 type design. The fully modified engine has an increased bypass ratio (5.8:1 to 9.0:1) and a variable fan pressure ratio. At takeoff power the modified engine produces the rated takeoff thrust of the standard CF6-6 engine with a 32 percent improvement in thrust specific fuel consumption (TSFC) and a turbine inlet temperature 460 deg F lower than the standard. At maximum continuous cruise power at 35,000 feet and Mn 0.8 the improvement in TSFC would be 18.8 percent and the turbine inlet temperature would be 270 deg F lower than the standard CF6-6 engine. The advantage in performance obtained by the increased bypass ratio and variable geometry fan more than offsets the increase in the engine weight that would result from these changes.

DTIC

N94-33451* General Electric Co., Cincinnati, OH. Aircraft Engines.
GENERAL ELECTRIC/PRATT AND WHITNEY SUMMARY REPORT
SAMUEL C. GILKEY and RICHARD W. HINES In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 1 p 137-195 Apr. 1992
Avail: CASI HC A04/MF A04

The views of GE and P&W on the High Speed Civil Transport (HSCT) are presented in viewgraph format. The technology developments needed to address the environmental issues of airport noise and engine emissions represent the threshold level for a viable program. These technologies must be introduced in concert with the

propulsion system materials technologies and other aircraft technologies to reduce both the cost of ownership and the direct operating cost of the HSCT. They are key to the environmental compatibility and economic viability of a HSCT for entry into service in the year 2005. CASI

N94-33463*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NASA HSR PHASE 1 LOW NOISE NOZZLE TECHNOLOGY PROGRAM OVERVIEW

BERNARD J. BLAHA *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 509-515 Apr. 1992

Avail: CASI HC A02/MF A04

The topics covered include the following: supersonic cruise, the High Speed Research (HSR) Program, the High Speed Civil Transport (HSCT) noise challenge, low-noise nozzle technology elements, the HSR Source Noise Reduction Program, and NASA HSR plan propulsion elements. Author

N94-33468*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NASA/LARC JET PLUME RESEARCH

JOHN M. SEINER, MICHAEL K. PONTON, and JAMES C. MANNING *In* its First Annual High-Speed Research Workshop, Part 2 p 609-644 Apr. 1992

Avail: CASI HC A03/MF A04

The following provides a summary for research being conducted by NASA/LARC and its contractors and grantees to develop jet engine noise suppression technology under the NASA High Speed Research (HSR) program for the High Speed Civil Transport (HSCT). The objective of this effort is to explore new innovative concepts for reducing noise to Federally mandated guidelines with minimum compromise on engine performance both in take-off and cruise. The research program is divided into four major technical areas: (1) jet noise research on advanced nozzles; (2) plume prediction and validation; (3) passive and active control; and (4) methodology for noise prediction. Author

N94-33476*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE NASA SPONSORED HSCT PROPULSION STUDIES

WILLIAM C. STRACK *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 813-827 Apr. 1992

Avail: CASI HC A03/MF A04

One objective of the NASA-sponsored High Speed Civil Transport (HSCT) propulsion studies is to determine the potential benefits of alternative advanced technologies. These benefits should be explicitly expressed in terms of meeting either environmental acceptability or economic viability. The potential benefit information is used to screen alternative technology candidates to the most promising technologies that, if successfully developed, will enable the propulsion system to achieve high performance and low weight without unduly sacrificing favorable emissions and noise characteristics. A second objective is the provision of key information to high-level decision makers—enabling them to make rational decisions concerning the technology program content. It will be necessary to pursue more than one concept/technology until experimental validity is convincingly demonstrated. Some technologies will likely fail to achieve their stated goals, and timely program redirection depends upon far-sighted system studies to provide such information. Author

N94-33477*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A NASA LEWIS COMPARATIVE PROPULSION SYSTEM ASSESSMENT FOR THE HIGH-SPEED CIVIL TRANSPORT

JEFFREY J. BERTON, WILLIAM J. HALLER, JONATHAN A. SEIDEL, and PAUL F. SENICK *In* NASA. Langley Research Center,

First Annual High-Speed Research Workshop, Part 2 p 831-865 Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: High Speed Research (HSR) Propulsion System Studies; HRS System Study flowpath; design point aircraft sizing - no noise constraint; impact of noise constraint; noise impact on aircraft size; takeoff gross weight assessment; impact of High Speed Civil Transport (HSCT) high-altitude flyover noise; HSR NO(x) reduction status; current assessment of HSCT ozone depletion; influence of non-optimum cruise altitude on range; and influence of subsonic leg on range. Author

N94-33478*# General Electric Co., Cincinnati, OH.

P AND W/GE PROPULSION SYSTEMS STUDIES

INTRODUCTION

SAMUAL C. GILKEY and RICHARD W. HINES *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 869-877 Apr. 1992

Avail: CASI HC A02/MF A04

The topics covered include the following: Pratt and Whitney (P&W)/ General Electric (GE) High Speed Civil Transport (HSCT) collaboration - joint propulsion studies and parallel technical organization; HSCT engine concepts; engine cycle/design ground rules - 2005 entry into service; engine evaluation criteria; 1991 HSCT system studies plan; P&W NASA study tasks; and GE NASA study tasks. Author

N94-33479*# General Electric Co., Cincinnati, OH. Aircraft Engines.

RESULTS OF GEAE HSCT PROPULSION SYSTEM STUDIES

FRED H. KRAUSE *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 881-917 Apr. 1992

Avail: CASI HC A03/MF A04

A very brief overview of the results of GE's High Speed Civil Transport (HSCT) propulsion system design studies is presented. Our plans for the remainder of this year are covered. Focus is on the acoustic nozzle design and its impact on the propulsion system performance. Our studies have shown that this component is a key driver on the HSCT propulsion and aircraft system designs. Cruise Cfg, acoustic performance, nozzle weight, and takeoff Cfg are all critical nozzle design features. Author

N94-33480*# Pratt and Whitney Aircraft, East Hartford, CT. Advanced Engine Programs.

P AND W PROPULSION SYSTEMS STUDIES RESULTS/STATUS

MARTIN G. SMITH, JR. and GEORGE A. CHAMPAGNE *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 921-947 Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: Pratt and Whitney (P&W) propulsion systems studies - NASA funded efforts to date; P&W engine concepts; P&W combustor focus - rich burn quick quench (RBQQ) concept; mixer ejector nozzle concept - large flow entrainment reduces jet noise; technology impact on NO(x) emissions - mature RBQQ combustor reduces NO(x) up to 85 percent; technology impact on sideline noise characteristics of Mach 2.4 turbine bypass engines (TBE's) - 600 lb/sec airflow size; technology impact on takeoff gross weight (TOGW) - provides up to 12 percent TOGW reduction; HSCT quiet engine concepts; TBE inlet valve/ejector nozzle concept schematic; mixed flow turbofan study; and exhaust nozzle conceptual design. Author

N94-33481*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

LOW EMISSIONS COMBUSTOR TECHNOLOGY FOR HIGH-SPEED CIVIL TRANSPORT ENGINES

RICHARD W. NIEDZWIECKI *In* NASA. Langley Research Center,

07 AIRCRAFT PROPULSION AND POWER

First Annual High-Speed Research Workshop, Part 2 p 953-964
Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: NASA High Speed Research (HSR) ozone research objectives; NO(x) formation; emission reduction; High Speed Civil Transport (HSCT) supersonic cruise combustion operating conditions; NO(x) correlations; typical NO(x) characteristics of a current technology and low NO(x) combustors; HSCT emission reduction strategies; variation of NO(x) with equivalence ratio; the Emission Reduction Program; and emission reduction milestones.

Author

N94-33486*# Pratt and Whitney Aircraft, East Hartford, CT. RICH BURN COMBUSTOR TECHNOLOGY AT PRATT AND WHITNEY

ROBERT P. LOHMANN and T. J. ROSFJORD In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 1045-1056 Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: near term objectives; rich burn quick quench combustor (RBQC); RBQC critical technology areas; cylindrical RBQC combustor rig; modular RBQC combustor; cylindrical rig objectives; quench zone mixing; noneffusive cooled liner; variable geometry requirements; and sector combustor rig.

Author

N94-33503*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PROPULSION AIRFRAME INTEGRATION SESSION OVERVIEW AND REVIEW OF LEWIS PAI EFFORTS

PETER G. BATTERTON In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1369-1379 Apr. 1992

Avail: CASI HC A03/MF A06

Propulsion/Airframe Integration (PAI) is a key issue for the High Speed Civil Transport. The aircraft performance, economics, and environmental acceptability can be adversely affected if the integration of the propulsion system and the airframe is not addressed properly or in a timely manner. Some of the goals are listed in this figure. In particular, these goals are highly influenced by how successfully the propulsion system and airframe are integrated. These goals were grouped by the 'Aero' and 'Propulsion' categories to suggest which group of technologists will likely be addressing them. In terms of the NASA High Speed Research Program, the ultimate objective for propulsion/airframe integration is to demonstrate the technologies for achievement of these goals on a 'single' integrated configuration.

Author (revised)

N94-33507*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

TRANSONIC AIRFRAME PROPULSION INTEGRATION

ROBERT E. COLTRIN, BOBBY W. SANDERS, and DANIEL P. BENCZE In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1439-1459 Apr. 1992

Avail: CASI HC A03/MF A06

This chart shows the time line for HSR propulsion/airframe integration program. HSR Phase 1 efforts are underway in both propulsion and aerodynamics. The propulsion efforts focus on cycles, inlets combustors and nozzles that will be required to reduce nitrogen oxide (NOX) at cruise and noise at takeoff and landing to acceptable levels. The aerodynamic efforts concentrate on concepts that will reduce sonic booms and increase the lift/drag (L/D) ratio for the aircraft. The Phase 2 critical propulsion component technology program will focus on large scale demonstrators of the inlet, fan, combustor, and nozzle. The hardware developed here will feed into the propulsion system program which will demonstrate overall system technology readiness, particularly in the takeoff and supersonic cruise speed ranges. The Phase 2 aerodynamic performance and vehicle integration program will provide a validated data base for advanced airframe/control/integration concepts over the

full HSR speed range. The results of this program will also feed into the propulsion system demonstration program, particularly in the critical transonic arena.

Author (revised)

N94-33510*# Boeing Commercial Airplane Co., Seattle, WA.

HSCT INTEGRATED PROPULSION CONTROL ISSUES

CHRISTOPHER M. CARLIN In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1507-1518 Apr. 1992

Avail: CASI HC A03/MF A06

The propulsion control system affects the economics of the HSCT through the mechanisms indicated. Weight reduction is paramount in an aircraft of this type. Significant reductions are possible relative to the SST or even current technology if improvements are made in areas such as high temperature electronics. Dependability is an increasingly important parameter in all aircraft, but the higher capital cost of the HSCT makes it doubly important. Conversely the more difficult HSCT design problem makes it more difficult to achieve. Integration of propulsion controls will make it possible to improve both the static and dynamic performance of the HSCT propulsion system. Noise and emissions requirements may introduce novel control system requirements such as automatically programmed takeoff thrust for noise abatement. Control system development technology is evolving. For HSCT, highly automated and thoroughly validated tools will be required to reliably achieve desired system performance at introduction, and to reduce development costs. A technology plan was developed to prepare for HSCT development. This presentation addresses the portion of the plan required to demonstrate technology readiness for the HSCT in the late 1990's rather than the technology development currently in progress.

Author (revised)

N94-33511*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ENABLING PROPULSION MATERIALS FOR HIGH-SPEED CIVIL TRANSPORT ENGINES

JOSEPH R. STEPHENS and THOMAS P. HERBELL In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1523-1546 Apr. 1992

Avail: CASI HC A03/MF A06

NASA Headquarters and LeRC have advocated an Enabling Propulsion Materials Program (EPM) to begin in FY-92. The High Speed Research Phase 1 program which began in FY-90 has focused on the environmental acceptability of a High Speed Civil Transport (HSCT). Studies by industry, including Boeing, McDonnell Douglas, GE Aircraft Engines, and Pratt & Whitney Aircraft, and in-house studies by NASA concluded that NO(x) emissions and airport noise reduction can only be economically achieved by revolutionary advancements in materials technologies. This is especially true of materials for the propulsion system where the combustor is the key to maintaining low emissions, and the exhaust nozzle is the key to reducing airport noise to an acceptable level. Both of these components will rely on high temperature composite materials that can withstand the conditions imposed by commercial aircraft operations. The proposed EPM program will operate in conjunction with the HSR Phase 1 Program and the planned HSR Phase 2 program slated to start in FY-93. Components and subcomponents developed from advanced materials will be evaluated in the HSR Phase 2 Program.

Author (revised)

N94-33706*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

MEASUREMENT OF THE COOLANT CHANNEL TEMPERATURES AND PRESSURES OF A COOLED RADIAL-INFLOW TURBINE

L. DANIELLE DICICCO, BRENT C. NOWLIN, and LIZET TIRRES Jun. 1994 15 p Presented at the 18th AIAA Aerospace Ground Testing Conference, Colorado Springs, CO, 20-23 Jun. 1994; sponsored by AIAA

(Contract RTOP 505-62-10)

(NASA-TM-106594; E-8866; NAS 1.15:106594; AIAA PAPER 94-2561) Avail: CASI HC A01/MF A01

Instrumentation has been installed on the surface of a cooled radial-inflow turbine. Thermocouples and miniature integrated sensor pressure transducers were installed to measure steady state coolant temperatures, blade wall temperatures, and coolant pressures. These measurements will eventually be used to determine the heat transfer characteristics of the rotor. This paper will describe the procedures used to install and calibrate the instrumentation and the testing methods followed. A limited amount of data will compare the measured values to the predicted values. Author

N94-33874# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.

GUIDE TO THE MEASUREMENT OF THE TRANSIENT PERFORMANCE OF AIRCRAFT TURBINE ENGINES AND COMPONENTS [GUIDE POUR LA MESURE DES PERFORMANCES EN TRANSITOIRE DES TURBOMACHINES AERONAUTIQUES ET DE LEURS COMPOSANTS]

EARL H. DUDGEON, ed. (National Research Council of Canada, Ottawa, Ontario.) Mar. 1994 404 p (AGARD-AR-320; ISBN-92-835-0739-8) Copyright Avail: CASI HC A18/MF A04

This report provides a guide for the measurement of transient aerothermodynamic performance parameters of aircraft gas turbine engines or components for engine developers, test agencies, certifying authorities, and operators of overhaul facilities and aircraft. It may be treated as an extension of AGARD Advisory Reports AR-245 and AR-248. It includes discussion of recommended procedures for the transient measurement of pressures, temperatures, flows, component geometry including rotational speed and clearances, thrust, torque, and the use of the engine control system for transient parameter measures. Typical examples are presented. A section on data acquisition and processing is included. Higher frequency dynamic measurements are excluded. Two examples, the measurement of compressor ratio and air flow at surge and a measurement of engine acceleration time are discussed in detail. This Advisory Report was prepared at the request of the Propulsion and Energetics Panel of AGARD. Author

N94-33955# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE EFFECTS OF VORTEX INGESTION ON THE FLOW IN A DIFFUSING S-DUCT

B. J. WENDT and B. A. REICHERT Jun. 1994 12 p Presented at the 30th Joint Propulsion Conference, Indianapolis, IN, 27-29 Jun. 1994; sponsored by AIAA, ASME, SAE, and ASEE (Contract RTOP 505-62-52)

(NASA-TM-106652; E-8964; NAS 1.15:106652; AIAA PAPER 94-2811) Copyright Avail: CASI HC A03/MF A01

An experimental study of the effects of an ingested vortex on the flowfield of a diffusing S-duct is reported. The vortex is generated through the use of a stationary pinwheel device mounted upstream of the diffusing S-duct. Three test conditions vary the location of the vortex in the duct inlet crossplane. For each condition of ingested vortex, a baseline S-duct and an S-duct with an array of vortex generators is examined. The data taken consist of duct inlet and exit crossplane surveys of velocity and total pressure. Duct surface flow visualization and static pressure are also recorded. The data acquired in these tests are compared to identical S-duct data taken in the absence of the ingested vortex. The ingested vortex is observed to have a strong influence on the flowfield inside (and exiting) the S-duct, but only when the vortex impinges at the inlet crossplane location coincident with the crossplane location of downstream flow separation within the duct. When the ingested vortex impinges at this location it reduces the extent of flowfield separation inside the baseline duct and promotes stronger crossflow in the exit plane of both the baseline duct and the duct with installed vortex generators. This enhanced crossflow also strengthens the vortices shed from

the vortex generators. The other impingement locations of the ingested vortex are found to produce little effect on the flowfield of the duct with or without vortex generators. Author

N94-33971# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

DESIGN OF A LOW ASPECT RATIO TRANSONIC COMPRESSOR STAGE USING CFD TECHNIQUES

NELSON L. SANGER Jun. 1994 18 p Presented at the 39th International Gas Turbine and Aeroengine Congress and Exposition, The Hague, Netherlands, 13-16 Jun. 1994; sponsored by ASME

(Contract RTOP 505-62-52)

(NASA-TM-106636; E-8938; NAS 1.15:106636) Avail: CASI HC A03/MF A01

A transonic compressor stage has been designed for the Naval Postgraduate School Turbopropulsion Laboratory. The design relied heavily on CFD techniques while minimizing conventional empirical design methods. The low aspect ratio (1.2) rotor has been designed for a specific head ratio of .25 and a tip relative inlet Mach number of 1.3. Overall stage pressure ratio is 1.56. The rotor was designed using an Euler code augmented by a distributed body force model to account for viscous effects. This provided a relatively quick-running design tool, and was used for both rotor and stator calculations. The initial stator sections were sized using a compressible, cascade panel code. In addition to being used as a case study for teaching purposes, the compressor stage will be used as a research stage. Detailed measurements, including non-intrusive LDV, will be compared with the design computations, and with the results of other CFD codes, as a means of assessing and improving the computational codes as design tools. Author

N94-33974# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

TIGGERC: TURBOMACHINERY INTERACTIVE GRID GENERATOR FOR 2-D GRID APPLICATIONS AND USERS GUIDE

DAVID P. MILLER May 1994 65 p Original contains color illustrations

(Contract RTOP 505-62-10)

(NASA-TM-106586; E-8850; NAS 1.15:106586) Avail: CASI HC A04/MF A01; 3 functional color pages

A two-dimensional multi-block grid generator has been developed for a new design and analysis system for studying multiple blade-row turbomachinery problems. TIGGERC is a mouse driven, interactive grid generation program which can be used to modify boundary coordinates and grid packing and generates surface grids using a hyperbolic tangent or algebraic distribution of grid points on the block boundaries. The interior points of each block grid are distributed using a transfinite interpolation approach. TIGGERC can generate a blocked axisymmetric H-grid, C-grid, I-grid or O-grid for studying turbomachinery flow problems. TIGGERC was developed for operation on Silicon Graphics workstations. Detailed discussion of the grid generation methodology, menu options, operational features and sample grid geometries are presented. Author

N94-34146# Pratt and Whitney Aircraft, East Hartford, CT.

COUPLED 2-DIMENSIONAL CASCADE THEORY FOR NOISE AND UNSTEADY AERODYNAMICS OF BLADE ROW INTERACTION IN TURBOFANS. VOLUME 1: THEORY DEVELOPMENT AND PARAMETRIC STUDIES Final Report

DONALD B. HANSON Washington Jan. 1994 81 p (Contract NAS3-25952; RTOP 535-03-10)

(NASA-CR-4506-VOL-1; E-7766-VOL-1; NAS 1.26:4506-VOL-1) Avail: CASI HC A05/MF A01

Typical analytical models for interaction between rotor and stator in a turbofan analyze the effect of wakes from the rotor impinging on the stator, producing unsteady loading, and thereby generating noise. Reflection/transmission characteristics of the rotor are sometimes added in a separate calculation. In those models, there is a one-to-one relationship between wake harmonics

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and noise harmonics; that is, the BPF (blade passing frequency) wake harmonic causes only the BPF noise harmonic, etc. This report presents a more complete model in which flow tangency boundary conditions are satisfied on two cascades in relative motion for several harmonics simultaneously. By an extension of S.N. Smith's code for two dimensional flat plate cascades, the noise generation/frequency scattering/blade row reflection problem is solved in a single matrix inversion. It is found that the BPF harmonic excitation of the stator scatters considerable energy in the higher BPF harmonics due to relative motion between the blade rows. Furthermore, when swirl between the rotor and stator is modeled, a 'mode trapping' effect occurs which explains observations on fans operating at rotational speeds below BPF cuton: the BPF mode amplifies between blade rows by multiple reflections but cannot escape to the inlet and exit ducts. However, energy scattered into higher harmonics does propagate and dominates the spectrum at two and three times BPF. This report presents the complete derivation of the theory, comparison with a previous (more limited) coupled rotor/stator interaction theory due to Kaji and Okazaki, exploration of the mode trapping phenomenon, and parametric studies showing the effects of vane/blade ratio and rotor/stator interaction. For generality, the analysis applies to stages where the rotor is either upstream or downstream of the stator and to counter rotation stages. The theory has been coded in a FORTRAN program called CUP2D, documented in Volume 2 of this report. It is concluded that the new features of this analysis - unsteady coupling, frequency scattering, and flow turning between rotor and stator - have a profound effect on noise generation caused by rotor/stator interaction. Treating rotors and stators as isolated cascades is not adequate for noise analysis and prediction.

Author (revised)

N94-34216* Colorado Univ., Boulder, CO. Dept. of Aerospace Engineering Sciences.

HIGH-PERFORMANCE PARALLEL ANALYSIS OF COUPLED PROBLEMS FOR AIRCRAFT PROPULSION Progress Report, Jul. 1993 - Jan. 1994

C. A. FELIPPA, C. FARHAT, S. LANTERI, N. MAMAN, S. PIPERNO, and U. GUMASTE May 1994 108 p

(Contract NAG3-1273)

(NASA-CR-195883; NAS 1.26:195883; CU-CAS-094-09) Avail: CASI HC A06/MF A02

This research program deals with the application of high-performance computing methods for the analysis of complete jet engines. We have entitled this program by applying the two dimensional parallel aeroelastic codes to the interior gas flow problem of a bypass jet engine. The fluid mesh generation, domain decomposition, and solution capabilities were successfully tested. We then focused attention on methodology for the partitioned analysis of the interaction of the gas flow with a flexible structure and with the fluid mesh motion that results from these structural displacements. This is treated by a new arbitrary Lagrangian-Eulerian (ALE) technique that models the fluid mesh motion as that of a fictitious mass-spring network. New partitioned analysis procedures to treat this coupled three-component problem are developed. These procedures involved delayed corrections and subcycling. Preliminary results on the stability, accuracy, and MPP computational efficiency are reported.

Author (revised)

N94-34231* Rotary Power International, Inc., Wood-Ridge, NJ. **STRATIFIED CHARGE ROTARY ENGINE CRITICAL TECHNOLOGY ENABLEMENT, VOLUME 1** Final Report, Feb. 1990 - 1992

C. E. IRION and R. E. MOUNT Aug. 1992 279 p

(Contract NAS3-25945; RTOP 505-62-10)

(NASA-CR-189106-VOL-1; E-8831-VOL-1; NAS 1.26:189106-VOL-1) Avail: CASI HC A13/MF A03

This report summarizes results of a critical technology enablement effort with the stratified charge rotary engine (SCRE) focusing on a power section of 0.67 liters (40 cu. in.) per rotor in single and two rotor versions. The work is a continuation of prior

NASA Contracts NAS3-23056 and NAS3-24628. Technical objectives are multi-fuel capability, including civil and military jet fuel and DF-2, fuel efficiency of 0.355 Lbs/BHP-Hr. at best cruise condition above 50 percent power, altitude capability of up to 10Km (33,000 ft.) cruise, 2000 hour TBO and reduced coolant heat rejection. Critical technologies for SCRE's that have the potential for competitive performance and cost in a representative light-aircraft environment were examined. Objectives were: the development and utilization of advanced analytical tools, i.e. higher speed and enhanced three dimensional combustion modeling; identification of critical technologies; development of improved instrumentation, and to isolate and quantitatively identify the contribution to performance and efficiency of critical components or subsystems.

Author

N94-34233* Rotary Power International, Inc., Wood-Ridge, NJ. **STRATIFIED CHARGE ROTARY ENGINE CRITICAL TECHNOLOGY ENABLEMENT. VOLUME 2: APPENDIXES** Final Report

C. E. IRION and R. E. MOUNT Aug. 1992 198 p

(Contract NAS3-25945; RTOP 505-62-10)

(NASA-CR-189106-VOL-2; E-8831-VOL-2; NAS 1.26:189106-VOL-2) Avail: CASI HC A09/MF A03

This second volume of appendixes is a companion to Volume 1 of this report which summarizes results of a critical technology enablement effort with the stratified charge rotary engine (SCRE) focusing on a power section of 0.67 liters (40 cu. in.) per rotor in single and two rotor versions. The work is a continuation of prior NASA Contracts NAS3-23056 and NAS3-24628. Technical objectives are multi-fuel capability, including civil and military jet fuel and DF-2, fuel efficiency of 0.355 Lbs/BHP-Hr. at best cruise condition above 50 percent power, altitude capability of up to 10Km (33,000 ft.) cruise, 2000 hour TBO and reduced coolant heat rejection. Critical technologies for SCRE's that have the potential for competitive performance and cost in a representative light-aircraft environment were examined. Objectives were: the development and utilization of advanced analytical tools, i.e. higher speed and enhanced three dimensional combustion modeling; identification of critical technologies; development of improved instrumentation; and to isolate and quantitatively identify the contribution to performance and efficiency of critical components or subsystems. A family of four-stage third-order explicit Runge-Kutta schemes is derived that required only two locations and has desirable stability characteristics. Error control is achieved by embedding a second-order scheme within the four-stage procedure. Certain schemes are identified that are as efficient and accurate as conventional embedded schemes of comparable order and require fewer storage locations.

Author

N94-34400 Research Triangle Inst., Research Triangle Park, NC. **TOXIC EMISSIONS FROM AIRCRAFT ENGINES: A SEARCH OF AVAILABLE LITERATURE**

Jul. 1993 91 p See also PB94-152303 Sponsored by EPA Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(PB94-156486; EPA/453/R-93/028) Avail: Issuing Activity (National Technical Information Service (NTIS))

The purpose of the work is to find what recent data are available to characterize toxic air emissions from aircraft engines as to specific compounds and their health effects. Specific items of interest are emissions from helicopter, civil, and military engines differentiated by mode of operation such as takeoffs, landings, taxiing, and idle.

NTIS

N94-34431* Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). **Propulsion and Energetics Panel.**

TECHNOLOGY REQUIREMENTS FOR SMALL GAS TURBINES [LES TECHNOLOGIES POUR LES PETITES TURBINES A GAS]

Mar. 1994 474 p In ENGLISH and FRENCH The 82nd

Symposium was held in Montreal, Quebec, 4-8 Oct. 1993. Original contains color illustrations
(AGARD-CP-537; ISBN-92-835-0738-X) Copyright Avail: CASI HC A20/MF A04

These Conference Proceedings contain the papers presented at the Propulsion and Energetics Panel 182nd Symposium on Technology Requirements for Small Turbines which was held from 4th-8th October 1993, in Montreal, Canada. The Technical Evaluation Report and the Technology Overview Address are included at the beginning, and discussions follow most papers. The Symposium was arranged in the following Sessions: Technology Overview; Turbohaft Engines; Turbofan Engines; Auxiliary Power Units; Compressors 1 - Centrifugal; Compressors 2 - Axial; Combustors; Turbines 1 - Axial; Turbines 2 - Radial; Structures and Materials; and Bearings.

N94-34432# Ministry of Defence, London (England). Directorate of Future Air Systems.

OPERATIONAL REQUIREMENTS FOR HELICOPTER ENGINES FOR UK SERVICES

M. D. PARAMOUR and P. G. JENNINGS In AGARD, Technology Requirements for Small Gas Turbines 9 p Mar. 1994
Copyright Avail: CASI HC A02/MF A04

This paper reviews the requirements of the United Kingdom Armed Services for helicopter engines and the technology developments that will be necessary to meet these requirements. The work that is being done in the UK to ensure that this technology is demonstrated in a timely manner is also examined. Reductions in defense budgets will have a considerable effect on the requirements, and the paper also addresses the effect such reductions will have on future technology. Whilst there continues to be a divergence between naval and land-based requirements, overriding importance is now being given by all operators to cost of ownership issues. The need to reduce the cost of ownership will therefore need to influence all the research and technology demonstration programs on which future engines will rely. Author

N94-34434# Technische Univ., Munich (Germany).

MTR390, THE NEW GENERATION TURBOHAFT ENGINE **AUGUST SPIRKL In AGARD, Technology Requirements for Small Gas Turbines 8 p Mar. 1994**

Copyright Avail: CASI HC A02/MF A04

In June 1993, the MTR390 has completed all its important certification tests. This marks a major step in the development and qualification program of this engine which was selected to power the new German/French anti-tank, support and attack helicopter, the EUROCOPTER TIGER and GERFAUT. The MTR390 is a new turboshaft engine in the 1000KW (1300shp) range being jointly developed by three of the largest European aero engine companies: MTU in Germany, TURBOMECA in France, and ROLLS-ROYCE in Great Britain. The joint company MTR GmbH which is registered in Germany, acts as contractor for the German and French governments. MTR directs and coordinates the development, production, marketing, sales, and customer support of the MTR390 engine for the Franco-German helicopters and other potential applications. The three companies have been working together for more than 25 years on several programs like Adour, Larzac, RB199, EJ200, RTM322,.... The declared goal of the MTR partner companies is to create an engine that will not only suit the TIGER/GERFAUT program but will also compete in the military and civil market for the next 20 to 30 years. Author

N94-34435# Alfa Romeo S.p.A., Naples (Italy). Research and Development.

AEROTHERMAL DESIGN OF 1600 K TET CORE ENGINE HOT-SECTION COMPONENTS FOR HIGH-TECHNOLOGY COMPACT PROPULSION SYSTEMS

S. COLANTUONI, A. COELLE, G. SANTORIELLO, L. CIRILLO, and C. IOSSA In AGARD, Technology Requirements for Small Gas Turbines 24 p Mar. 1994

Copyright Avail: CASI HC A03/MF A04

The paper describes the aerodynamic and thermal design for the hot-section core engine components, i.e. the combustor and the HP turbine, for an application related to a propulsion system of 1000 kW class. The annular reverse-flow flame-tube is very compact in length and radial dimensions. The high pressure gas-generator turbine is an axial-flow single stage, aerodynamically high loaded, and has nozzle vanes as well as rotor blades cooled by impingement, film cooling and forced enhanced convection techniques. Furthermore the core engine hot section rig has been designed to allow, through an extensive experimental program, the verification of the performances, and to study the impact of the cooling systems on the thermo-mechanical behavior of the components. Author

N94-34436# Pisa Univ. (Italy). Dipt. di Energetica.

NON-POLLUTING GAS TURBINE AS A RESULT OF SELF-HEATING WORKING FLUID IN A CLOSED CIRCUIT

DINO DINI In AGARD, Technology Requirements for Small Gas Turbines 5 p Mar. 1994

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Design and experimental results of a small turboshaft operating with self-heating working fluid are presented here. The working fluid is water steam produced through H₂, O₂, H₂O combustion, water being injected gradually on the H₂/O₂ stoichiometric combustion products. High pressure (50 divided by 70 bar) and high temperature (1000 divided by 1500 K) water steam is involved, respectively, because of mechanically driven pumps for liquid hydrogen and oxygen and water, and because their combustion. So, water steam is operating the turboshaft until vacuum pressure condenses in an aircondenser after a previous heat exchange, in a closed cycle. Only a part of the steam latent heat is going to the environment. An overall thermodynamic design, and a more detailed combustor design, are presented, showing high cycle efficiency and validity for such a non-polluting turboshaft. Experimental results of the H₂/O₂/H₂O combustor are reported. Applications are suggested for small power entertainment airplanes, rescue helicopters, and non-polluting airport ground vehicles. Author

N94-34437# Army Aviation Research and Development Command, Cleveland, OH. Vehicle Propulsion Directorate.

ANALYSIS OF RIG TEST DATA FOR AN AXIAL/CENTRIFUGAL COMPRESSOR IN THE 12 KG/SEC

A. K. OWEN In AGARD, Technology Requirements for Small Gas Turbines 30 p Mar. 1994 Sponsored by NASA. Lewis Research Center

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Extensive testing was done on a T55-L-712 turboshaft engine compressor in a compressor test rig at TEXTRON/Lycoming. These rig tests will be followed by a series of engine tests to occur at the NASA Lewis Research Center beginning in the last quarter of 1993. The goals of the rig testing were: (1) map the steady state compressor operation from 20 percent to 100 percent design speed, (2) quantify the effects of compressor bleed on the operation of the compressor, and (3) explore and measure the operation of the compressor in the flow ranges 'beyond' the normal compressor stall line. Instrumentation consisted of 497 steady state pressure sensors, 153 temperature sensors and 34 high response transducers for transient analysis in the pre- and post-stall operating regime. These measurements allow for generation of detailed stage characteristics as well as overall mapping. Transient data is being analyzed for the existence of modal disturbances at the front face of the compression system ('stall precursors'). This paper presents some preliminary results of the ongoing analysis and a description of the current and future program plans. It will primarily address the

unsteady events at the front face of the compression system that occur as the system transitions from steady state to unsteady (stall/surge) operation. Author

**N94-34438# Williams International, Walled Lake, MI.
EXPENDABLE GAS TURBINE ENGINE TECHNOLOGY
ADVANCES**

G. S. CRUZEN In AGARD, Technology Requirements for Small Gas Turbines 8 p Mar. 1994

Copyright Avail: CASI HC A02/MF A04

New materials and component technologies are undergoing feasibility assessment in expendable gas turbine demonstrator engines. The new technologies, developed under the Integrated High Performance Turbine Engine Technologies (IHPTET) and other initiatives, address the need for improved engine performance, lower cost, and lighter weight. Engine and rig tests conducted on high temperature composite turbine components, fuel-lubricated ceramic bearings, low cost, light weight organic composite structures, and a novel low cost cooled turbine rotor concept are described in this paper. Also, additional development requirements for transitioning these technologies to production applications are defined. Author

N94-34439# BMW Rolls-Royce AeroEngines G.m.b.H., Lohrhof (Germany).

EXPERIMENTAL INVESTIGATION AND PERFORMANCE ANALYSIS OF THE TURBOJET ENGINE T117

GERNOT EISENLOHR and PETER HOECHST In AGARD, Technology Requirements for Small Gas Turbines 7 p Mar. 1994

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The T117 Turbojet Engine (formerly KHD T117) is a single shaft light weight turbojet of the 1000 N thrust class. It was especially developed to fit into the reconnaissance drone Canadair CL 289. The demand for smallest possible size of the compressor to fit the constraints of outer diameter and axial length of the complete engine showed early that only a single stage radial compressor would be applicable. The compression system of this turbojet is described in some detail. The performance maps of the compressor at the test-stand without and with turbojet inlet system are shown. Calculated and measured operating lines in the performance maps show good agreement. Tests with several production engines to establish the compressor performance map are shown and they confirm the compressor map with turbojet inlet system at the compressor test-stand. Enough surge margin for the jet-engine is demonstrated. Investigations with curve flight simulation show a stable performance of the jet engine. Author

N94-34440# Microturbo, Toulouse (France). Chemin du Pont de Rupe.

MICROTURBO'S EXPERIENCE IN THE FIELD OF APU FOR CIVIL AND MILITARY APPLICATIONS AND OUR ROLE IN THE FACE OF THE CHALLENGES OF THE FUTURE [EXPERIENCE DE LA SOCIETE MICROTURBO DANS LE DOMAINE DES GROUPEUX AUXILIAIRES DE PUISSANCE POUR LES BESOINS MILITAIRES ET CIVILS: NOUVELLES EXIGENCES POUR L'AVENIR]

NORBERT HIRTZ and CHARLES MISCHER In AGARD, Technology Requirements for Small Gas Turbines 14 p Mar. 1994 In FRENCH

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For more than thirty years, Microturbo has designed, developed, and manufactured gas turbines to supply mechanical and pneumatic power for a multitude of applications: airborne and land based; and civil and military. Over the years, continuous technological improvements in engine aerodynamics, thermodynamics, combustion, mechanics, acoustics, and a parallel modernization of fuel management and other engine systems, has enabled Microturbo to develop a range of products which are specifically geared to today's demands and perfectly adapted to those of the future. A summary of the efforts of Microturbo is presented. Author (revised)

N94-34441# Turbomeca S.A. - Brevets Szydlowski, Bordes (France).

SPECIFICATIONS OF AUXILIARY POWER UNITS FOR CONFORMITY WITH HELICOPTER TURBOSHAFT ENGINES [SPECIFICITE DES GROUPEUX AUXILIAIRES DE PUISSANCE PAR RAPPORT AUX TURBOMOTEURS D'HELICOPTERE]

JOEL SILET In AGARD, Technology Requirements for Small Gas Turbines 14 p Mar. 1994 In FRENCH

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Despite an apparent similarity with helicopter turboshaft engines--in terms of power level, construction, and type of components--Auxiliary Power Units (APU) have special needs that differ from those of helicopter gas turbine engines. The differences can be found in the following areas: integration of aircraft pneumatic and electric systems; combustion chambers; low acoustic levels; low oil consumption; and efficiency requirements. Author (revised)

N94-34442 # Fiat Aviazione S.p.A., Turin (Italy). Direzione Progettazione.

THE DEVELOPMENT OF AN AUXILIARY POWER UNIT FOR A FIGHTER AIRCRAFT

C. VINCI, E. CAMPO, and A. TROVATI In AGARD, Technology Requirements for Small Gas Turbines 18 p Mar. 1994

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The design of an APU is a comprise between several, often conflicting, requirements: installation constraints, performance, duty cycle, weight, reliability, and Life Cycle Cost. This document presents a summary of the significant technology developments that were accomplished on a FiatAvio Auxiliary Power Unit. The APU is a two-spool modular gas turbine that has a pneumatic power rating of 150 HP. A particular effort was dedicated to the development of the full authority digital control system. The APU was certified in 1987, and the first production unit entered service a year and a half later. Author (revised)

**N94-34443# Textron Lycoming, Stratford, CT.
ADVANCED CONCEPTS FOR NEXT GENERATION SMALL
GAS TURBINE ENGINE COMPRESSORS**

ARUN K. SEHRA and HOWARD F. MERRICK In AGARD, Technology Requirements for Small Gas Turbines 7 p Mar. 1994

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The trend in advanced gas turbine engines is towards light-weight, high performance, compact, reliable compression systems. This has created a need for a compression system capable of delivering extremely high stage pressure ratios. Textron Lycoming is currently developing multistage axial compressors with average pressure ratios in excess of 2.5 and single axial stages capable of delivering pressure ratios in excess of 3.5. Major advances in the aerodynamic design techniques and material/structural technologies are necessary to achieve the performance and weight objectives of these compression systems. This paper describes some of the recent advances made in the aero design concepts (swept shock rotors, splintered rotors), computational fluid mechanics, active stabilization system, and material/structural innovations (metal matrix composite titanium aluminide impellers) to meet the challenge of the next generation of gas turbine compression systems. Author (revised)

N94-34444# Pratt and Whitney Aircraft of Canada Ltd., Longueuil (Quebec).

ADVANCED SMALL HIGH PRESSURE RATIO CENTRIFUGAL COMPRESSOR

M. H. KALOGIANNIS, A. D. LEBLANC, and S. M. PRZYBYTKOWSKI In AGARD, Technology Requirements for Small Gas Turbines 6 p Mar. 1994

Copyright Avail: CASI HC A02/MF A04

This paper describes the design approach for a high pressure ratio, single-stage, centrifugal compressor that meets current small helicopter engine performance requirements. Test results are pro-

vided for a 10:1 pressure ratio single-stage having 80 percent efficiency and 27 percent surge margin. Development of three dimensional computational fluid dynamics has generated the tools to design impellers with improved surge margin while maintaining state of the art efficiency. Further development of Euler and Navier-Stokes codes is required to analytically optimize the impeller-diffuser match and to improve efficiency levels. Author (revised)

N94-34445# Turbomeca S.A. - Brevets Szydlowski, Bordes (France).

THE CENTRIFUGAL COMPRESSOR, AN ESSENTIAL COMPONENT OF SMALL AND MEDIUM POWER ENGINES [LE COMPRESSEUR CENTRIFUGE, COMPOSANT ESSENTIEL DES TURBOMOTEURS DE PETITE ET MOYENNE PUISSANCE]

P. BELAYGUE and H. VIGNAU In AGARD, Technology Requirements for Small Gas Turbines 15 p Mar. 1994 In FRENCH Original contains color illustrations

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Originally, the centrifugal compressor formed the basis of the first aeronautical applications of turboshaft engines. Recently, it has been almost exclusively used behind axial compressors as the last compression stage in turbines of small and medium power, with a moderate pressure ratio. As a result of numerous studies which have been carried out during the last two decades, it has been elevated to a key position. Thanks to the progress in the field of analytical tools (concerning aerodynamics, structures, and heat transfer), materials, and processes, its characteristics are such that, besides its traditional use as the last compression stage, it can also perform the following functions: (1) form the only compression stage (up to a compression ratio of 12); and (2) be combined with another centrifugal stage to reach an overall pressure ratio of 20 without using variable geometry. Because of the great simplicity of the assembly, its intrinsic performance (efficiency, pressure ratio, surge margin, low sensitivity to clearances, and distortions) as well as its ease of integration, it is considered as an essential component to be used in an helicopter engine, the requirements of which can be classified as follows: high specific power, very good reliability, low cost, and performance compromise—cruise specific consumption, emergency power, and response time in transient condition. Its present capacity to run with higher specific flows and the use of variable geometry open new doors to other applications: jet engines and auxiliary power units. Author (revised)

N94-34446# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL AND COMPUTATIONAL RESULTS FROM A LARGE LOW-SPEED CENTRIFUGAL IMPELLER

M. D. HATHAWAY (Army Aviation Research and Development Command, Cleveland, OH.), R. M. CHRISS, J. R. WOOD, and A. J. STRAZISAR In AGARD, Technology Requirements for Small Gas Turbines 11 p Mar. 1994 See also N94-20136

Copyright Avail: CASI HC A03/MF A04

An experimental and computational investigation of the NASA Low-Speed Centrifugal Compressor (LSCC) flow field was conducted using laser anemometry and Dawes' 3D viscous code. The experimental configuration consists of a back-swept impeller followed by a vaneless diffuser. Measurements of the three-dimensional velocity field were acquired at several measurement planes through the compressor. The measurements describe both the throughflow and secondary velocity field along each measurement plane and, in several cases, provide details of the flow within the blade boundary layers. The experimental and computational results provide a clear understanding of the development of the through flow momentum wake which is characteristic of centrifugal compressors. Author (revised)

N94-34449# Sundstrand Power Systems, San Diego, CA. **COMPACT DIFFUSERS FOR SMALL TRANSONIC COMPRESSORS**

COLIN RODGERS In AGARD, Technology Requirements for

Small Gas Turbines 22 p Mar. 1994

Copyright Avail: CASI HC A03/MF A04

Smaller, smarter, airbreathing propelled tactical missiles are being proposed and developed. They will function for various military duties currently performed by larger, limited range missiles or manned surveillance and interdiction aircraft. The extreme compactness of these missiles requires relatively high power density small turbojets. The missile air inlet location and configuration in many of these applications may impose highly distorted compressor inlet flow conditions, with potentially deleterious effects upon compressor performance, both in terms of flow range stability and compression efficiency. Renewed interest has therefore been focused upon alternative compressor design solutions with improved stability, more tolerant to flow distortion effects. In this respect, splitting the compression diffusion process into multirow or tandem cascades has been proposed as a means of attaining increased flow range and efficiency, both in axial and centrifugal compressors. Centrifugal compressors are popular for small, low cost, expendable missiles, especially with compact diffusers permitting reduced frontal area. An experimental study of the effect of a tandem radial cascade diffuser configuration on the performance of a small, high specific speed transonic centrifugal compressor stage is described in this paper. Tests showed the importance of the first tandem row on overall compressor performance and demonstrated higher flow range at the expense of slightly reduced efficiency, as compared to an optimum channel type diffuser. Author

N94-34452# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMBUSTOR TECHNOLOGY FOR FUTURE SMALL GAS TURBINE AIRCRAFT

VALERIE J. LYONS and RICHARD W. NIEDZWIECKI In AGARD, Technology Requirements for Small Gas Turbines 17 p Mar. 1994 See also N94-13142

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To enhance fuel efficiency, future advanced small gas turbine engines will utilize engine cycles calling for overall engine pressure ratios, leading to higher combustor inlet pressures and temperatures. Further, the temperature rise through the combustor and the corresponding exit temperature are also expected to increase. This report describes future combustor technology needs for small gas turbine engines. New fuel injectors with large turndown ratios which produce uniform circumferential and radial temperature patterns will be required. Uniform burning will be of greater importance because hot gas temperatures will approach turbine material limits. The higher combustion temperatures and increased radiation at high pressures will put a greater heat load on the combustor liners. At the same time, less cooling air will be available as more of the air will be used for combustion. Thus, improved cooling concepts and/or materials requiring little or no direct cooling will be required. Although presently there are no requirements for emissions levels from small gas turbine engines, regulation is anticipated in the near future. This will require the development of low emission combustors. In particular, nitrogen oxides will increase substantially if new technologies limiting their formation are not evolved and implemented. For example, staged combustion employing lean, premixed/prevaporized, lean direct injection, or rich burn-quick quench-lean burn concepts could replace conventional single stage combustors. Due to combustor size considerations, staged combustion is more easily accommodated in large engines. The inclusion of staged combustion in small engines will pose greater combustor design challenges. Author

N94-34453# General Electric Co., Lynn, MA. Aircraft Engines Div.

COMBUSTOR TECHNOLOGY FOR SMALL AIRCRAFT ENGINES

STEPHEN HOWELL In AGARD, Technology Requirements for Small Gas Turbines 9 p Mar. 1994

Copyright Avail: CASI HC A02/MF A04

A review of aircraft gas turbine engine performance trends

indicates that the smaller the engine the lower are its cycle pressure ratios, which suggests the less the combustor design challenge. This is often reflected in projected development effort. In fact, many aspects of combustor design and performance are adversely affected in smaller engines. Furthermore, when emission reduction requirements are extended to smaller engines, the design comprises needed to meet all performance goals will become particularly acute, and design solutions from large combustors may not be applicable. Author

N94-34454# Pratt and Whitney Aircraft of Canada Ltd., Longueuil (Quebec).

LOW EMISSION COMBUSTOR TECHNOLOGY FOR SMALL AIRCRAFT GAS TURBINES

H. C. EATOCK and P. SAMPATH *In* AGARD, Technology Requirements for Small Gas Turbines 15 p Mar. 1994 Sponsored by Dept. of National Defence and Dept. of Industry, Trade and Commerce Original contains color illustrations

Copyright Avail: CASI HC A03/MF A04

This paper addresses small aircraft gas turbine emissions from the viewpoints of environmental impact and control technologies. Improvements achieved in small engine emissions without regulatory control are highlighted, as well as limitations on applicability of 'large-engine' technologies due to scale constraints and the highly cost-sensitive small engine market. Author

N94-34455# Pratt and Whitney Aircraft of Canada Ltd., Longueuil (Quebec).

REDUCING TEMPERATURE DISTRIBUTION FACTOR (TDF) FOR ADVANCED SMALL GAS TURBINE ENGINES

L. A. PROCIW, T. C. J. HU, and R. R. HASTINGS *In* AGARD, Technology Requirements for Small Gas Turbines 27 p Mar. 1994 Original contains color illustrations

Copyright Avail: CASI HC A03/MF A04

This paper discusses CFD applications to the analysis and optimization of the temperature distribution factor (TDF) in small, high intensity complex flow field gas turbine combustors. TDF is a term used to describe the nonuniformity of the temperature profile in the combustor exit plane which results from the inability to fully mix out temperature peaks. Hot end durability will be locally affected by temperature peaks whereas total energy exchange is dependent on the gas path bulk average temperature rise. Control of the TDF thus allows increased overall efficiency from both the cycle temperature and cooling load perspective while minimizing hot end distress. Computational fluid dynamic analysis of three dimensional combustor flows and the empirical validation of results are used to demonstrate the effectiveness of CFD as a design tool in this challenging environment. Author

N94-34456# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany).

DEVELOPMENT OF A HP-TURBINE FOR A SMALL HELICOPTER ENGINE

H.-J. DIETRICH, F. MALZACHER, and K. BROICHHAUSEN *In* AGARD, Technology Requirements for Small Gas Turbines 8 p Mar. 1994

Copyright Avail: CASI HC A02/MF A04

High specific power and a small SFC are major objectives in the development of advanced turbo shaft engines. The reduced number of turbine stages leads to a considerable increase of their aerodynamic loading. The design and development of a transonic single stage turbine for a pressure ratio P_i equals 3.6 was carried out at MTU in a technology and demonstration program. Results of the extensive annular cascade, cold flow rig, and gas generator engine testing are presented including detailed investigations of transonic vane and blade flow fields, stator/rotor matching effects, and the influence of film cooling flow and tip clearance variations on the turbine performance. Author (revised)

N94-34457# Technische Univ., Dresden (German D.R.). Inst. fuer Energietechnik.

THE INFLUENCE OF THE INLET BOUNDARY LAYERS ON THE SECONDARY LOSSES OF TURBINE STAGES

H. SAUER and H. WOLF *In* AGARD, Technology Requirements for Small Gas Turbines 6 p Mar. 1994 Sponsored by Ministry of Science and Technology

Copyright Avail: CASI HC A02/MF A04

The efficiency level of turbine stages with small blade height is mainly determined by the endwall losses because they are significantly higher than the profile losses. In spite of extensive research work in this field, there are still some unsatisfactorily solved problems. The paper deals with two problems: the increase of the endwall losses downstream the cascade and the influence of the cascade inlet boundary layer thickness on the endwall losses. Because the inlet boundary layer is twisted mainly by the tip clearance vortex of the cascade upstream, the effect of a skewed inlet boundary layer is shown as well. Finally, measurement results of a turbine stage with blade height L equals 30 mm ($D(\text{sub } m)/L$ equals 13) are shown for the cases with and without shroud. Author (revised)

N94-34458# National Research Council of Canada, Ottawa (Ontario). Turbomachinery Aerodynamics Group.

EFFECT OF TIP CLEARANCE ON THE PERFORMANCE OF A HIGHLY LOADED TURBINE STAGE

U. W. SCHAUB, E. VLASIC, and S. H. MOUSTAPHA *In* AGARD, Technology Requirements for Small Gas Turbines 11 p Mar. 1994 Prepared in cooperation with Pratt and Whitney Aircraft of Canada Ltd., Longueuil, Quebec

Copyright Avail: CASI HC A03/MF A04

This paper describes the performance of a highly loaded turbine stage with a pressure ratio of 3.75 and a stage loading of 2.47. Tests were carried out with two rotor blade counts at design and 70 percent speeds for a range of tip clearances from 1.1 to 2.1 percent of blade span. The results are presented in the form of radial distribution of stage exit swirl and efficiency and are compared with the prediction of a 3-D Euler flow solver. The measured efficiency drop for a 1 percent change in tip clearance is 2.6 and 1.1 percentage points at 100 and 70 percent speed, respectively. The efficiency drop reduced from 2.6 to 1.7 percentage points with a 33 percent reduction in blade count. The effect of clearance variation on stage exit conditions was seen to extend over most of the blade span. Author

N94-34459*# Allied-Signal Aerospace Co., Phoenix, AZ. Turbine Aerodynamics.

DESIGN AND AERODYNAMIC PERFORMANCE EVALUATION OF A HIGH-WORK MIXED FLOW TURBINE STAGE

REMO N. NERI, THOMAS J. ELLIOTT, DAVID N. MARSH, and KESTUTIS C. CIVINSKAS *In* AGARD, Technology Requirements for Small Gas Turbines 16 p Mar. 1994 Sponsored by NASA. Lewis Research Center and Army Research Lab.

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As axial and radial turbine designs have been pushed to their aerothermodynamic and mechanical limits, the mixed-flow turbine (MFT) concept has been projected to offer performance and durability improvements, especially when ceramic materials are considered. The objective of this NASA/U.S. Army sponsored mixed-flow turbine (AMFT) program was to determine the level of performance attainable with MFT technology within the mechanical constraints of 1997 projected ceramic material properties. The MFT geometry is similar to a radial turbine, exhibiting a large radius change from inlet to exit, but differing in that the inlet flowpath is not purely radial, nor axial, but mixed; it is the inlet geometry that gives rise to the name 'mixed-flow'. The 'mixed' orientation of the turbine inlet offers several advantages over radial designs by allowing a nonzero inlet blade angle yet maintaining radial-element blades. The oblique inlet

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

N94-32713 Colorado Univ., Boulder, CO.
NUMERICAL ANALYSIS OF TRANSONIC WING BUFFET Ph.D. Thesis

SHEN-JWU SU 1992 151 p

Avail: Univ. Microfilms Order No. DA9318138

Transonic wing buffet is caused by shock-induced boundary layer separation on the wing. The inherent fluctuating buffet force can significantly reduce the flight performance of an airplane. An analysis of transonic wing buffet phenomena using modern numerical techniques is described here. The numerical tool developed for this purpose can accurately compute the solution for turbulent flow over a wing at high Reynolds numbers and at fairly high angles of attack. The computer code consists of two major parts: a three dimensional multiple block grid generation package, and an implicit finite difference code for solving the thin-layer compressible Navier-Stokes equations. Wind tunnel data for transonic flow past a swept ONERA M6 wing were used for code validation. The computed pressure distributions compared favorably with measurements. The buffet boundaries were predicted for the M6 wing, and the corresponding shock boundary-layer interaction during buffet onset was described. In order to avoid the separation penalties and to raise the buffet boundaries in the transonic speed regime, two types of wing designs, namely the twisted wing and step wing concepts, have been studied here. They were implemented separately by modifying the M6 wing geometry. The results indicate that both types of wing modifications can significantly alter the shock-wave and boundary-layer characteristics in a favorable way to reduce the rise of shock-induced separation on the wing and thus efficiently raise the buffet onset boundary. To examine the complex separated flow pattern obtained from numerical simulation, the concept of envelope of limiting streamlines and topology of phase plane was discussed. This provides a generalized approach to the classification of three dimensional separated flow patterns defined by streamlines for flow at or away from a solid surface.

Dissert. Abstr.

N94-32951* National Aeronautics and Space Administration.
Langley Research Center, Hampton, VA.

MODELING OF AIRCRAFT UNSTEADY AERODYNAMIC CHARACTERISTICS. PART 1: POSTULATED MODELS

VLADISLAV KLEIN (George Washington Univ., Hampton, VA.) and KEITH D. NODERER (George Washington Univ., Hampton, VA.)

May 1994 26 p

(Contract RTOP 505-64-52-01)

(NASA-TM-109120; NAS 1.15:109120) Avail: CASI HC A03/MF A01

A short theoretical study of aircraft aerodynamic model equations with unsteady effects is presented. The aerodynamic forces and moments are expressed in terms of indicial functions or internal state variables. The first representation leads to aircraft integro-differential equations of motion; the second preserves the state-space form of the model equations. The formulations of unsteady aerodynamics is applied in two examples. The first example deals with a one-degree-of-freedom harmonic motion about one of the aircraft body axes. In the second example, the equations for longitudinal short-period motion are developed. In these examples, only linear aerodynamic terms are considered. The indicial functions are postulated as simple exponentials and the internal state variables are governed by linear, time-invariant, first-order differential equations. It is shown that both approaches to the modeling of unsteady aerodynamics lead to identical models.

Author

not only improves the particle-impact survivability of the design, but improves the aerodynamic performance by reducing the incidence at the blade inlet. The difficulty, however, of using mixed-flow geometry lies in the scarcity of detailed data and documented design experience. This paper reports the design of a MFT stage designed with the intent to maximize aerodynamic performance by optimizing design parameters such as stage reaction, rotor incidence, flowpath shape, blade shape, vane geometry, and airfoil counts using 2-D, 3-D inviscid, and 3-D viscous computational fluid dynamics code. The aerodynamic optimization was accomplished while maintaining mechanical integrity with respect to vibration and stress levels in the rotor. A full-scale cold-flow rig test was performed with metallic hardware fabricated to the specifications of the hot ceramic geometry to evaluate the stage performance.

Author

N94-34460# Cranfield Inst. of Tech., Bedford (England). Dept. of Turbomachinery and Engineering Mechanics.

NOZZLE GUIDE VANE FLOW IN RADIAL INFLOW TURBINES
SOHAIL H. ZAIDI and ROBIN L. ELDER In AGARD, Technology Requirements for Small Gas Turbines 13 p Mar. 1994 Sponsored by European Research Office

Copyright Avail: CASI HC A03/MF A04

Radial inflow turbines have various applications in industry and are being used as major components of gas turbines and turbochargers. The details of the flow phenomena within these machines are ill-defined especially in small high speed units where small passages and high velocities are involved. To gain a better understanding of these flow processes, a small radial inflow turbine has been studied using laser anemometry. The main area of interest has been the region between the nozzle guide vanes and the turbine rotor. The flow in this region has been investigated at several positions across the nozzle guide vane pitch and span. The influence of the passing blades on the guide vane flow has also been studied. The results obtained have been compared with those from a previously studied (comparative) unit. The flow phenomena from the two machines differ quite markedly in the extent of the distortion observed at the nozzle guide vane and rotor interface.

Author

N94-34461# Ulstein Turbine A/S, Kongsberg (Norway).

TURBINE BLADE DYNAMICS AND BLADE-VANE INTERACTION IN A RADIAL INFLOW TURBINE

A. WILSON and T. UTENGEN In AGARD, Technology Requirements for Small Gas Turbines 11 p Mar. 1994

Copyright Avail: CASI HC A03/MF A04

This paper is divided into two parts. In the first part it describes the aerodynamic design of radial flow nozzle guide vanes (NGV's) and the excitation forces from the NGV flow on the rotor. The second part, which is the section on structural analysis, describes the design efforts made for avoiding serious vibration problems in a radial inflow turbine.

Author

N94-34465# National Research Council of Canada, Ottawa (Ontario). Structures and Materials Lab.

HOT SECTION MATERIALS FOR SMALL TURBINES

A. K. KOUL In AGARD, Technology Requirements for Small Gas Turbines 10 p Mar. 1994 (Contract IAR PROJ. CJ501)

Copyright Avail: CASI HC A02/MF A04

This paper reviews unique requirements for hot section materials for small (less than 5000 lb. St.) axial flow turbines. Recent developments in integrally cast wheels, conventionally cast blades and vanes, directionally solidified and single crystal blades, conventionally forged and gatorized discs, and coatings technologies are summarized. Hot section materials trends for future engine designs, particularly in light of USAF MIL-STD-1783 requirements, are also discussed.

Author

08 AIRCRAFT STABILITY AND CONTROL

N94-33086# Naval Postgraduate School, Monterey, CA.
FAULT DETECTION AND ISOLATION FOR THE BLUEBIRD TEST BED AIRCRAFT M.S. Thesis

MARIO J. LEVESQUE Dec. 1993 117 p

(AD-A277979) Avail: CASI HC A06/MF A02

A Fault Detection and Isolation (FDI) algorithm design is presented using the Multiple Model algorithm technique for the Bluebird aircraft being developed at the Naval Postgraduate School. The requirement to maintain high performance in the dynamic system of the aircraft necessitates the use of FDI techniques to detect and isolate malfunctions in the sensors and actuators of the aircraft without using hardware redundancy. The solution presented makes use of analytical redundancy in a bank of Kalman filters. Statistical tests using Bayesian theory are applied on the filter's innovations to perform the task of detection and isolation. The algorithm was developed using MATLAB software from The Math Works, Inc. The work presented in this thesis is related only to the task of FDI. The remaining task of the monitoring system, reconfiguration and continued operation by the observed plant after a failure detection, will not be addressed. DTIC

N94-33378*# National Aeronautics and Space Administration.
Langley Research Center, Hampton, VA.

A COMPUTER PROGRAM TO OBTAIN TIME-CORRELATED GUST LOADS FOR NONLINEAR AIRCRAFT USING THE MATCHED-FILTER-BASED METHOD Final Report

ROBERT C. SCOTT, ANTHONY S. POTOTZKY, and BOYD PERRY, III Feb. 1994 46 p

(Contract DTFA03-89-A-00019)

(NASA-TM-109768; NAS 1.15:109768; AD-A278236; DOT/FAA/CT-93/63) Avail: CASI HC A03/MF A01

NASA Langley Research Center has, for several years, conducted research in the area of time-correlated gust loads for linear and nonlinear aircraft. The results of this work led NASA to recommend that the Matched-Filter-Based One-Dimensional Search Method be used for gust load analyses of nonlinear aircraft. This manual describes this method, describes a FORTRAN code which performs this method, and presents example calculations for a sample nonlinear aircraft model. The name of the code is MFD1DS (Matched-Filter-Based One-Dimensional Search). The program source code, the example aircraft equations of motion, a sample input file, and a sample program output are all listed in the appendices. DTIC

N94-33543 Air Force Inst. of Tech., Wright-Patterson AFB, OH.
School of Engineering.

A HANDLING QUALITIES INVESTIGATION OF CONVENTIONAL, RATE COMMAND AND ATTITUDE HOLD, AND ATTITUDE COMMAND AND ATTITUDE HOLD RESPONSE TYPES IN THE PROBE AND DROGUE AIR REFUELING TASK M.S. Thesis

MICHAEL J. TASCHNER Mar. 1994 315 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A278464; AFIT/GAE/ENY/94M-4) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This investigation examines the suitability of conventional, rate command/attitude hold (RCAH), and attitude command attitude hold (ACAH) response-types for the probe and drogue air refueling task. Data from a 1974 Calspan handling qualities investigation involving conventional response-types in the probe and drogue air refueling task were analyzed using the Bandwidth and STI Dropback criteria. Flight control laws were developed to achieve twelve superelemented and two conventional configurations. The NT-33A analog variable stability system was used to simulate a relaxed static stability fighter and the NT-33A programmable digital flight control computer simulated the desired response-types. The handling qualities of the fourteen configurations were evaluated during eight flight test sorties. Data consisted of pilot commentary, handling qualities ratings using the Cooper-Harper rating scale, pilot induced oscillation tendency ratings, and turbulence ratings. The bandwidth

criterion supplemented with frequency response based control sensitivity metrics successfully correlated the observed handling qualities. Configurations with handling qualities deficiencies were characterized by any one of the following: excessive gain at the pitch and flight path bandwidths, excessive phase delay, low bandwidth, or a gain margin limited pitch attitude bandwidth. DTIC

N94-33998*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, CA.

PILOTED SIMULATION STUDY OF TWO TILT-WING FLAP CONTROL CONCEPTS, PHASE 2

LOURDES G. BIRCKELBAW, LLOYD D. CORLISS, WILLIAM S. HINDSON, and GARY B. CHURCHILL Apr. 1994 69 p

(Contract RTOP 505-61-51)

(NASA-TM-108817; A-94072; NAS 1.15:108817) Avail: CASI HC A04/MF A01

A two phase piloted simulation study has been conducted in the Ames Vertical Motion Simulator to investigate alternative wing and flap controls for tilt-wing aircraft. This report documents the flying qualities results and findings of the second phase of the piloted simulation study and describes the simulated tilt-wing aircraft, the flap control concepts, the experiment design and the evaluation tasks. The initial phase of the study compared the flying qualities of both a conventional programmed flap and an innovative geared flap. The second phase of the study introduced an alternate method of pilot control for the geared flap and further studied the flying qualities of the programmed flap and two geared flap configurations. In general, the pilot ratings showed little variation between the programmed flap and the geared flap control concepts. Some differences between the two control concepts were noticed and are discussed in this report. The geared flap configurations had very similar results. Although the geared flap concept has the potential to reduce or eliminate the pitch control power requirements from a tail rotor or a tail thruster at low speeds and in hover, the results did not show reduced tail thruster pitch control power usage with the geared flap configurations compared to the programmed flap configuration. The addition of pitch attitude stabilization in the second phase of simulation study greatly enhanced the aircraft flying qualities compared to the first phase. Author

N94-34264*# Santa Clara Univ., CA. Dept. of Mechanical Engineering.

VISION-BASED AIRCRAFT GUIDANCE Final Report, 1 Feb. 1993 - 14 Dec. 1993

P. K. MENON Dec. 1993 15 p

(Contract NCC2-793)

(NASA-CR-195937; NAS 1.26:195937) Avail: CASI HC A03/MF A01

Early research on the development of machine vision algorithms to serve as pilot aids in aircraft flight operations is discussed. The research is useful for synthesizing new cockpit instrumentation that can enhance flight safety and efficiency. With the present work as the basis, future research will produce low-cost instrument by integrating a conventional TV camera together with off-the-shelf digitizing hardware for flight test verification. Initial focus of the research will be on developing pilot aids for clear-night operations. Latter part of the research will examine synthetic vision issues for poor visibility flight operations. Both research efforts will contribute towards the high-speed civil transport aircraft program. It is anticipated that the research reported here will also produce pilot aids for conducting helicopter flight operations during emergency search and rescue. The primary emphasis of the present research effort is on near-term, flight demonstrable technologies. This report discusses pilot aids for night landing and takeoff and synthetic vision as an aid to low visibility landing. Derived from text

N94-34326# Nanjing Aeronautical Inst. (China). Dept. of Automatic Control.

INTEGRATED FLIGHT/THRUST CONTROL SYSTEMS WITH CONSTANT ANGLE-OF-ATTACK

YI-DONG YANG and ZHONG YANG *In its Proceedings of the Asia-*

Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 75-79 1993
 Avail: CASI HC A01/MF A03

The integrated flight/thrust control system with constant angle of attack, i.e. APCS (Approach Power Compensator System), can obviously raise an aircraft's performance of maneuver and make the flight path change in response to the attitude commands swift and accurate. Working principles of three APCS schemes, composition and effective parameters designing methods of their control laws are discussed in this study. The last two schemes presented by this paper, leading an attitude signal or an attitude command into the throttle, are the improved APCS's which make the general flight/thrust control systems better. This paper, which may be used as a theoretical instruction, is to present concrete methods to the design of current precision path guidance systems, especially of the APCS in the ACLD (Automatic Carrier Landing Systems). Author

N94-34327# Nanjing Aeronautical Inst. (China).

ROBUST VARIABLE STRUCTURE FLIGHT CONTROL SYSTEM
 AN-HONG SUN and CHUN-LIN SHEN *In its Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 80-84 1993*
 Avail: CASI HC A01/MF A03

This paper develops a new robust variable structure system with the theory of robust control and variable structure control, and introduces it into the design of aircraft control systems. Because the variable structure system itself is robust for some parameter disturbances, so adopting the idea of robust control in the design of variable structure system has been of more significance. Numerical simulation shows that the result is good. Author

N94-34328# Nanjing Aeronautical Inst. (China).

AIRCRAFT OPTIMAL VARIABLE STRUCTURE CONTROL SYSTEM
 AN-HONG SUN and CHUN-LIN SHEN *In its Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 85-89 1993*
 Avail: CASI HC A01/MF A03

This paper develops a new design method for aircraft control system, which is called 'optimal variable craft control system.' This system can make the aircraft keep good control performance in different space areas; it compensates the deficiency of the classical design of PID. Furthermore, because of that it can be realized easily in engineering, so it is a more practical and effective design method. Digital simulation shows that the result is good. Author

N94-34329# Nanjing Aeronautical Inst. (China). Dept. of Automatic Control.

THE DECOUPLING DESIGN OF AIRCRAFT LATERAL FLIGHT CONTROL SYSTEMS WITH EIGENSTRUCTURE ASSIGNMENT
 SHU-FAN WU and SUO-FENG GUO *In its Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 90-94 1993*
 Avail: CASI HC A01/MF A03

A lateral stability augmentation and attitude pilot system for a Boeing-707 transport model is analyzed and designed with eigenstructure assignment method. The concepts and principles of eigenstructure assignment methods are first summarized. The extended aircraft lateral dynamics, including actuator dynamics and a washout filter on the yaw rate, is modeled as a multivariable time-invariant state equation, with seven state variables, two control inputs, and four measurement outputs. The desired (respective) eigenstructure are selected according to the requirements on the transient performances and on the decoupling dynamics between roll and yaw maneuvering. Both the full output and the constrained

output feedback strategies are used in the closed-loop system design. Digital simulation results are illustrated. Author

N94-34330# Nanjing Aeronautical Inst. (China).

H INFINITY OPTIMAL DESIGN OF ROBUST FLIGHT CONTROL SYSTEM
 CHANG-SHENG JIANG, CHUN-LIN SHEN, CHANG-YIN ZHANG, and DAI-YE LIN *In its Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 95-98 1993* Sponsored by National Natural Science Foundation of China
 Avail: CASI HC A01/MF A03

In this paper, a discussion is devoted to the H infinity optimal design problem of robust flight control system. This paper gives practical engineering design methods and procedures and develops corresponding design software package. In the meanwhile, it is illustrated by H infinity optimal design examples of flight control system that the design methods and procedures and software package are useful. Author

N94-34331# Nanjing Aeronautical Inst. (China). Dept. of Automatic Control.

THE TRACKING CONTROL OF NONLINEAR UNCERTAIN SYSTEMS
 XIAO LIU, JIN-QUAN HUANG, and JU JIANG *In its Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 99-103 1993*
 Avail: CASI HC A01/MF A03

The robust trajectory tracking control of a class of nonlinear uncertain systems is studied in this paper. It is assumed that there are uncertain variations in the systems parameters and unknown disturbance inputs acting on the system. The linearized nominal system is obtained by using feedback linearization technique. Then, a model-following structure based upon linear quadratic regulator theory is used to guarantee the linearized nominal system tracks the reference trajectory. Based on the Lyapunov stability theory, a nonlinear control law is derived such that the outputs of overall systems behaves as the closed-loop linearized nominal system. An example is presented to illustrate the approach. Author

N94-34337# Hankuk Aviation Univ., Kyunggido (Republic of Korea). Dept. of Aeronautical and Mechanical Engineering.

TRIM CALCULATION OF TANDEM ROTOR HELICOPTER USING SIMPLIFIED ROTOR SYSTEM MATHEMATICAL MODEL
 MYOUNG-SHIN HWANG and KANG-WOONG LEE *In Nanjing Aeronautical Inst., Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 126-130 1993*
 Avail: CASI HC A01/MF A03

To evaluate advanced research concepts relating to navigation, guidance, and control of a helicopter, a mathematical model is required. In this paper we describe a technique for determining the trims and quasistatic derivatives of a tandem rotor helicopter using a linear perturbation model with a simplified rotor system mathematical model. The results of this model show an acceptable agreement with referenced values. Author

N94-34406 Department of the Navy, Washington, DC.

ADAPTIVE AUTOPILOT Patent
 DEWEY P. ANKENY, inventor (to Navy) 28 Sep. 1993 4 p Filed 20 Jun. 1974
 (AD-D016193; US-PATENT-5,248,114; US-PATENT-APPL-SN-481570; US-PATENT-CLASS-244-3) Avail: US Patent and Trademark Office

An autopilot system is introduced including parameter identification circuits wherein the function of the torque and the function of the translational force on a missile are unknown and varying (including approaching zero). DTIC

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

N94-32473*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HIGH PERFORMANCE REAL-TIME FLIGHT SIMULATION AT NASA LANGLEY

JEFF I. CLEVELAND, II In NASA, Washington, Technology 2003: The Fourth National Technology Transfer Conference and Exposition, Volume 2 p 456-462 Feb. 1994

Avail: CASI HC A02/MF A04

In order to meet the stringent time-critical requirements for real-time man-in-the-loop flight simulation, computer processing operations must be deterministic and be completed in as short a time as possible. This includes simulation mathematical model computational and data input/output to the simulators. In 1986, in response to increased demands for flight simulation performance, personnel at NASA's Langley Research Center (LaRC), working with the contractor, developed extensions to a standard input/output system to provide for high bandwidth, low latency data acquisition and distribution. The Computer Automated Measurement and Control technology (IEEE standard 595) was extended to meet the performance requirements for real-time simulation. This technology extension increased the effective bandwidth by a factor of ten and increased the performance of modules necessary for simulator communications. This technology is being used by more than 80 leading technological developers in the United States, Canada, and Europe. Included among the commercial applications of this technology are nuclear process control, power grid analysis, process monitoring, real-time simulation, and radar data acquisition. Personnel at LaRC have completed the development of the use of supercomputers for simulation mathematical model computational to support real-time flight simulation. This includes the development of a real-time operating system and the development of specialized software and hardware for the CAMAC simulator network. This work, coupled with the use of an open systems software architecture, has advanced the state of the art in real time flight simulation. The data acquisition technology innovation and experience with recent developments in this technology are described. Author (revised)

N94-32474*# ECC International Corp., Orlando, FL.

THE EFFECTS OF ABOVE REAL-TIME TRAINING (ARTT) IN AN F-16 SIMULATOR

DUTCH GUCKENBERGER, KAY STANNEY, and NORMAN E. LANE In NASA, Washington, Technology 2003: The Fourth National Technology Transfer Conference and Exposition, Volume 2 p 463-470 Feb. 1994

Avail: CASI HC A02/MF A04

In this application of above real-time training (ARTT), 24 mission-capable F-16 pilots performed three tasks on a part-task F-16A flight simulator under varying levels of time compression (i.e., 1.0x, 1.5x, 2.0x, and random). All subjects were then tested in a real-time (1.0x) environment. The three tasks under study were an emergency procedure (EP) task, a one versus two air combat maneuvering (ACM) task, and a stern conversion or air intercept task. All ARTT pilots performed the EP task with 28 percent greater accuracy and were better at dealing with a simultaneous MIG threat, reflected by a six-fold increase in the number of MIG kills compared to a real-time control group. In the stern conversion task, there were no statistical differences between groups. In the ACM task, those pilots trained in the mixed time accelerations were faster to acquire lock and were faster to kill both MIG threats than the other groups. These findings are generally consistent with previous findings that show positive effects of task variations (including time variations) during training. Also discussed are related research findings that

support the benefits of ARTT and ARTT's impact on emergency procedure training. Further, a synthesis of multidiscipline research outlining the underlying theoretical basis for ARTT is presented. A proposed model of ARTT based on an analogy to Einstein's theory of special relativity is suggested. Conclusions and an outline of future research directions are presented. Successful current commercialization efforts are related as well as future efforts.

Author (revised)

N94-33139 Naval Postgraduate School, Monterey, CA.

AN EVALUATION FRAMEWORK FOR DESIGNING A NIGHT VISION, COMPUTER-BASED TRAINER M.S. Thesis

ERIC W. CAUDLE Dec. 1993 63 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A278005) Avail: CASI HC A04

The mission requirement of low-level, nighttime navigation employing night vision goggles has expanded. This has led to a greater demand for training NVG skills and initiated a requirement for a low-cost, desktop, computer-based trainer (CBT). A framework is presented in this thesis that includes a review of the technology available for designing a night vision CBT. System attributes and constraints are identified and analyzed; and evaluation criteria developed to allow for examination of alternative system configurations. Two configurations are developed one PC-based and one workstation-based. These configurations present different cost/benefit components. A sample in graphics capabilities, processor performance and peripheral support is provided for the two configurations. In addition, cost range estimates are included and possible baseline capabilities established to assist in the determination process. DTIC

N94-33167 Calspan-Buffalo Univ. Research Center, NY.

CALIBRATION AND VALIDATION STUDIES IN THE LENS FACILITY Final Report, 10 Aug. 1991 - 9 Feb. 1994

MICHAEL HOLDEN 9 Feb. 1994 60 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract F49620-91-C-0085)

(AD-A278403; AFOSR-94-0161TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report describes recent developments in the LENS facility, flow field calibration studies, and aerothermal and aero-optical measurements to evaluate the turbulent flow field characteristics of seeker head configurations in hypervelocity airflow. The development of the LENS facility to run at pressure levels up to 30,000 psi and temperatures up to 14,000 degrees R are reviewed. Issues associated with diaphragm performance, reservoir configuration, throat melting and burning, and modifications to the facility for large recoil loads at high pressure operation are briefly reviewed. Flow field measurements made during calibration studies are compared with computer predictions. Validation studies with simple seeker head aperture configurations in high enthalpy flows are then discussed. The models and aerothermal and aero-optical instrumentation used in these studies are described. The measurements obtained in flows up to 12,000 ft/sec are compared with similar measurements at lower velocities, simple correlation techniques, and detailed computer simulations. DTIC

N94-33424 Naval Surface Warfare Center, Dahlgren, VA.

HYPERVELOCITY TUNNEL 9 MACH 8 CALIBRATION

NANCY F. SWINFORD 10 Mar. 1994 47 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A277575; NSWCDD/TR-93/40) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report documents the Mach 8 Calibration test program (WTR 1614) performed in the Navy's Hypervelocity Wind Tunnel (Tunnel 9). This was an in-house calibration test effort. Free stream flow field measurements were obtained for the Mach 8 nozzle, covering a wide range of Reynolds numbers. The calibration

included running very low Reynolds numbers, not previously calibrated at Mach 8, as well as running at the current maximum supply conditions for Mach 8. The test period was 18 to 23 December 1992, with a total of five runs. Results from this test entry were combined with previous Mach 8 calibration data in the final analysis. Previous calibration data were taken when Mach 8 was originally brought on-line in December of 1988. The maximum supply conditions were lower during the original calibration than are currently available. However, data from this most recent calibration reveal that high quality uniform flow still exists and that deviations in core flow field parameters are comparable with other Tunnel 9 calibration data taken to date. DTIC

N94-33444 Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.

CONTINGENCY AIRFIELD CONSTRUCTION: MECHANICAL STABILIZATION USING MONOFILAMENT AND FIBRILLATED FIBERS Final Report

RANDY C. AHLRICH and LEE E. TIDWELL Jan. 1994 53 p Sponsored by Wright Lab. Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A277732; WES/TR-GL-94-2) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report documents a laboratory study that evaluated the effectiveness of mechanically stabilizing low strength soils with monofilament and fibrillated fibers. The study provides guidance on fiber type, length, and dosage rate to produce stabilized soils for contingency airfield construction. This study included a review of available literature and a two-phase laboratory test program. The basis of this study was to determine the feasibility of using fibers to significantly enhance the strength of low-strength soils. The soil materials used in the laboratory study were a high plasticity clay (CH) and a beach sand (SP). Each soil was tested to determine the optimum moisture content, maximum dry density, and soaked and as-molded CBR strengths. The clay and sand materials were then stabilized with monofilament and fibrillated fibers at various lengths and dosages. These stabilized materials were then evaluated with the Corps of Engineers gyratory testing machine to determine gyratory shear strength properties. The stabilized soils that indicated an increase in gyratory shear strength were evaluated with the laboratory CBR procedure to determine the soaked and as-molded CBR strength values. The findings of this study indicated that the monofilament fibers can improve strength values of beach sand and the fibrillated fibers can improve the strength values of a high plasticity clay. This laboratory study also indicated that the CBR test may not evaluate the effectiveness of fiber stabilization. DTIC

N94-33538 MiTech, Inc., Pleasantville, NJ.

IMPROVED TAXIWAY EXIT IDENTIFICATION SYSTEM

ERIC KATZ and THOMAS PAPROCKI Feb. 1994 28 p Sponsored by FAA Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A277892; DOT/FAA/CT-TN93/49) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

A prototype enhanced visual taxiway identification system, consisting of a segment of green lights imbedded within the conventional runway centerline lighting system, was developed and tested at the Federal Aviation Administration (FAA) Technical Center. Results of the combined developmental/evaluational effort indicated that the system may be expected to provide enhanced and effective identification of taxiway exit locations at minimum cost. DTIC

N94-33570* National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.

HIGH HEAT FLUX FACILITY (Videotape)

1993 Videotape: 4 min. 50 sec. playing time, in color, with sound (NASA-TM-109834; NONP-VT-94-12962) Avail: CASI VHS A01/BETA A22

This video gives an overview of the High Heat Flux Facility

being built at Stennis Space Center in conjunction with Wright-Patterson Air Force Base. This facility will simulate flight heat conditions and will be used to test engine and materials for the National Aerospace Plane. CASI

N94-33604* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

POWERED LIFT FACILITY AT NASA LEWIS RESEARCH CENTER'S AEROACOUSTIC PROPULSION LABORATORY

GAIL P. PERUSEK Jun. 1994 19 p Presented at the 18th Aerospace Ground Test Conference, Colorado Springs, CO, 20-23 Jun. 1994; sponsored by AIAA (Contract RTOP 505-62-84) (NASA-TM-106577; E-8830; NAS 1.15:106577; AIAA PAPER 94-2560) Avail: CASI HC A03/MF A01

The Powered Lift Facility (PLF) is a unique and valuable ground test facility at the NASA Lewis Research Center designed to accommodate several types of test programs that support the analytical and experimental research on supersonic short-takeoff and vertical-landing (SSTOVL) aircraft. Major systems of the PLF are discussed: thrust balance, air supply, mass flow measuring, instrumentation and data acquisition, and auxiliary support. For potential users of the PLF, details are given about the requirements for model design, instrumentation, and deliverables. Author

N94-33751* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ICING RESEARCH TUNNEL (Videotape)

Jan. 1990 Videotape: 7 min. 39 sec. playing time, in color, with sound

(NASA-TM-109844; REPT-4001; NONP-VT-94-13534) Avail: CASI VHS A01/BETA A22

This video gives the history of the Icing Research Tunnel at LeRC and how it is used today to understand and protect against icing. CASI

N94-34071* National Aeronautics and Space Administration, Washington, DC.

NATIONAL FACILITIES STUDY Summary Report

29 Apr. 1994 36 p Prepared in cooperation with DOD, Washington, DC; Commerce Dept., Washington, DC; DOE, Washington, DC; and DOT, Washington, DC

(NASA-TM-109851; NAS 1.15:109851) Avail: CASI HC A03/MF A01

This study provides a set of recommendations for improving the effectiveness of our nation's aeronautics and space facilities. The study plan considers current and future government and commercial needs as well as DOD and NASA mission requirements through the year 2023. It addresses shortfalls in existing capabilities, new facility requirements, upgrades, consolidations, and phase-out of existing facilities. If the recommendations are implemented, they will provide world-class capability where it is vital to our country's needs and make us more efficient in meeting future needs. Derived from text

N94-34104# Federal Aviation Administration, Washington, DC. Research and Development.

SAFE HELIPORTS THROUGH DESIGN AND PLANNING Final Report

ROBERT D. SMITH Feb. 1994 122 p (DOT/FAA/RD-93/17) Avail: CASI HC A06/MF A02

During the last decade, the Federal Aviation Administration (FAA) has published several dozen research and development (R&D) reports dealing with the planning and design of landing sites for vertical flight aircraft. These landing sites include helipads at airports, heliports, helistops, vertiports, and unimproved sites. Vertical flight aircraft include helicopters, tiltrotor, and tiltwing. These reports would make a stack that is several feet high. Airport, heliport, and vertiport planners and designers should be familiar with FAA R&D efforts in this area. We recognize, however, that many people do not have the time to read all of the published material. In addition,

10 ASTRONAUTICS

without a 'road map' through all of this material, it may be difficult to see how multiple documents fit together to tell a coherent story on a particular subject of interest. With this in mind, the FAA has prepared this summary to assist you in becoming familiar with the results of these efforts. Author

10 ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

N94-32870* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RESULTS FOR THE HYBRID LAMINAR FLOW CONTROL EXPERIMENT CONDUCTED IN THE NASA LANGLEY 8-FOOT TRANSONIC PRESSURE TUNNEL ON A 7-FOOT CHORD MODEL

PERCY J. BOBBITT, JAMES C. FERRIS, WILLIAM D. HARVEY, and SURESH H. GORADIA Mar. 1992 18 p

(Contract RTOP 505-69-20-01)

(NASA-TM-107582; NAS 1.15:107582) Avail: CASI HC A03/MF A01

A description is given of the development of, and results from, the hybrid laminar flow control (HLFC) experiment conducted in the NASA LaRC 8 ft Transonic Pressure Tunnel on a 7 ft chord, 23 deg swept model. The methods/codes used to obtain the contours of the HLFC model surface and to define the suction requirements are outlined followed by a discussion of the model construction, suction system, instrumentation, and some example results from the wind tunnel tests. Included in the latter are the effects of Mach number, suction level, and the extent of suction. An assessment is also given of the effect of the wind tunnel environment on the suction requirements. The data show that, at or near the design Mach number, large extents of laminar flow can be achieved with suction mass flows over the first 25 percent, or less, of the chord. Top surface drag coefficients with suction extending from the near leading edge to 20 percent of the chord were approximately 40 percent lower than those obtained with no suction. The results indicate that HLFC can be designed for transonic speeds with lift and drag coefficients approaching those of LFC designs but with much smaller extents and levels of suction. Author (revised)

N94-33323* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

LOAD-LIMITING LANDING GEAR FOOTPAD ENERGY ABSORPTION SYSTEM

CHRIS HANSEN and TED TSAI In NASA. Lewis Research Center, The 28th Aerospace Mechanisms Symposium p 429-441 May 1994 Avail: CASI HC A03/MF A04

As a precursor to future manned missions to the moon, an inexpensive, unmanned vehicle that could carry small, scientific payloads to the lunar surface was studied by NASA. The vehicle, called the Common Lunar Lander, required extremely optimized structural systems to increase the potential payload mass. A lightweight energy-absorbing system (LAGFEAS), which also acts as a landing load-limiter was designed to help achieve this optimized structure. Since the versatile and easily tailored system is a load-limiter, it allowed for the structure to be designed independently of the ever-changing landing energy predictions. This paper describes the LAGFEAS system and preliminary verification testing performed at NASA's Johnson Space Center for the Common Lunar Lander program. Author

N94-33423* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.

DEBRIS/ICE/TPS ASSESSMENT AND INTEGRATED PHOTOGRAPHIC ANALYSIS FOR SHUTTLE MISSION STS-62 Final Report, 2-21 Mar. 1994

GREGORY N. KATNIK, BARRY C. BOWEN, J. BRADLEY DAVIS, ROBERT F. SPEECE, and JORGE E. RIVERA May 1994 138 p Original contains color illustrations (NASA-TM-109201; NAS 1.15:109201) Avail: CASI HC A07/MF A02; 56 functional color pages

A pre-launch debris inspection of the pad and Shuttle vehicle was conducted on 2 March 1994. The detailed walkdown of Launch Pad 39B and MLP-1 also included the primary flight elements OV-102 Columbia (16th flight), ET-62 (LWT 55), and BI-064 SRB's. There were no significant facility or vehicle anomalies. After the launch on March 4th, a debris inspection of Pad 39B was performed. Damage to the pad overall was minimal. On-orbit photographs taken by the flight crew and two films from the ET/ORB umbilical cameras of the External Tank after separation from the Orbiter revealed no major damage or lost flight hardware that would have been a safety of flight concern. Orbiter performance on final approach appeared normal. Infrared imagery of landing gear deployment showed the loss of thermal barrier from the nose gear wheel well. The missing thermal barrier material was not recovered. The Solid Rocket Boosters were inspected at Hanger AF after retrieval. Both frustums had a combined total of 44 MSA-2 debonds over fasteners. Significant amounts of BTA had been applied to closeouts on the RH frustum, forward skirt, and aft skirt. Hypalon paint was blistered/missing over the areas where the BTA had been applied. The underlying BTA was not sooted (IFA STS-62-B-1). Investigation of this condition has concluded there was insufficient heat rates to cause blistering of the Hypalon until late in the ascent phase. A post landing inspection of OV-102 was conducted after the landing at KSC. The Orbiter TPS sustained a total of 97 hits, of which 16 had a major dimension of 1 inch or larger. The Orbiter lower surface had a total of 36 hits, of which 7 had a major dimension of 1 inch or larger. Based on these numbers and comparison to statistics from previous missions of similar configuration, both the total number of debris hits and the number of hits 1 inch or larger was less than average. Six thermal barriers, total size approximately 36 in. x 3 in. x 1.5 in., and one corner tile piece 4 in. x 4 in., were missing from the nose landing gear doors. Runway infrared cameras recorded these objects falling from the Orbiter when the nose landing gear doors were opened on final approach. A search of the area under the flight path failed to recover the missing thermal batteries, which may be submerged in the large body of water south of the runway. The cause for the loss of the material was attributed to the way the substrate was prepared for bonding at the vendor. Orbiter post landing microchemical sample results revealed a variety of residuals in the Orbiter window samples. These were attributed to SRB BSM exhaust, Orbiter TPS, window protective covers and processing, natural landing site products, and paints/primers from various sources. The residual sampling data do not indicate a single source of damaging debris and all of these materials have been documented previously in analyses for post landing sample reports. Data from residual sampling also showed no trends when compared to previous mission data. A total of ten Post Launch Anomalies, including one IFA, were observed during the STS-62 mission assessment.

Derived from text

N94-34063* Eloret Corp., Palo Alto, CA.

HIGH-TEMPERATURE BEHAVIOR OF ADVANCED SPACECRAFT TPS Final Technical Report, 1 Feb. 1987 - 31 Jan. 1994

JOAN PALLIX 10 May 1994 13 p

(Contract NCC2-462)

(NASA-CR-195832; NAS 1.26:195832) Avail: CASI HC A03/MF A01

The objective of this work has been to develop more efficient, lighter weight, and higher temperature thermal protection systems

(TPS) for future reentry space vehicles. The research carried out during this funding period involved the design, analysis, testing, fabrication, and characterization of thermal protection materials to be used on future hypersonic vehicles. This work is important for the prediction of material performance at high temperature and aids in the design of thermal protection systems for a number of programs including programs such as the National Aerospace Plane (NASP), Pegasus and Pegasus/SWERVE, the Comet Rendezvous and Flyby Vehicle (CRAF), and the Mars mission entry vehicles. Research has been performed in two main areas including development and testing of thermal protection systems (TPS) and computational research. A variety of TPS materials and coatings have been developed during this funding period. Ceramic coatings were developed for flexible insulations as well as for low density ceramic insulators. Chemical vapor deposition processes were established for the fabrication of ceramic matrix composites. Experimental testing and characterization of these materials has been carried out in the NASA Ames Research Center Thermophysics Facilities and in the Ames time-of-flight mass spectrometer facility. By means of computation, we have been better able to understand the flow structure and properties of the TPS components and to estimate the aerothermal heating, stress, ablation rate, thermal response, and shape change on the surfaces of TPS. In addition, work for the computational surface thermochemistry project has included modification of existing computer codes and creating new codes to model material response and shape change on atmospheric entry vehicles in a variety of environments (e.g., earth and Mars atmospheres). Author (revised)

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

N94-32860*# McDonnell Aircraft Co., Saint Louis, MO.
DEVELOPMENT OF THERMOPLASTIC COMPOSITE AIRCRAFT STRUCTURES Final Report, Apr. 1989 - Apr. 1991

MICHAEL P. RENIERI, STEVEN J. BURPO, LANCE M. ROUNDY, STEPHANIE A. TODD, and H. J. KIM Mar. 1992 121 p Original contains color illustrations
(Contract NAS1-18862)
(NASA-CR-189593; NAS 1.26:189593) Avail: CASI HC A06/MF A02; 4 functional color pages

Efforts focused on the use of thermoplastic composite materials in the development of structural details associated with an advanced fighter fuselage section with applicability to transport design. In support of these designs, mechanics developments were conducted in two areas. First, a dissipative strain energy approach to material characterization and failure prediction, developed at the Naval Research Laboratory, was evaluated as a design/analysis tool. Second, a finite element formulation for thick composites was developed and incorporated into a lug analysis method which incorporates pin bending effects. Manufacturing concepts were developed for an upper fuel cell cover. A detailed trade study produced two promising concepts: fiber placement and single-step diaphragm forming. Based on the innovative design/manufacturing concepts for the fuselage section primary structure, elements were designed, fabricated, and structurally tested. These elements focused on key issues such as thick composite lugs and low cost forming of fastenerless, stiffener/moldline concepts. Manufacturing techniques included autoclave consolidation, single diaphragm consolidation (SDCC) and roll-forming. Author

N94-32863*# Boeing Co., Renton, WA.
APPLICATION OF A DESIGN-BUILD-TEAM APPROACH TO LOW COST AND WEIGHT COMPOSITE FUSELAGE

STRUCTURE Report, 15 May 1989 - 31 Jul. 1990

L. B. ILCEWICZ, T. H. WALKER, K. S. WILLDEN, G. D. SWANSON, G. TRUSLOVE, S. L. METSCHAN, and C. L. PFAHL Dec. 1991 146 p

(Contract NAS1-18889; RTOP 510-02-13-01)

(NASA-CR-4418; NAS 1.26:4418) Avail: CASI HC A07/MF A02

Relationships between manufacturing costs and design details must be understood to promote the application of advanced composite technologies to transport fuselage structures. A team approach, integrating the disciplines responsible for aircraft structural design and manufacturing, was developed to perform cost and weight trade studies for a twenty-foot diameter aft fuselage section. Baseline composite design and manufacturing concepts were selected for large quadrant panels in crown, side, and keel areas of the fuselage section. The associated technical issues were also identified. Detailed evaluation of crown panels indicated the potential for large weight savings and costs competitive with aluminum technology in the 1995 timeframe. Different processes and material forms were selected for the various elements that comprise the fuselage structure. Additional cost and weight savings potential was estimated for future advancements. Author

N94-32868*# Southwest Research Inst., San Antonio, TX. Engine, Fuel, and Vehicle Research Div.

IGNITION DELAYS, HEATS OF COMBUSTION, AND REACTION RATES OF ALUMINUM ALKYL DERIVATIVES USED AS IGNITION AND COMBUSTION ENHANCERS FOR SUPERSONIC COMBUSTION Final Report

THOMAS W. RYAN, III, S. T. SCHWAB, and W. W. HARLOWE Feb. 1992 20 p

(Contract NAS1-18191; SWRI PROJ. 01-1302; RTOP 505-62-40-01)

(NASA-CR-189581; NAS 1.26:189581) Avail: CASI HC A03/MF A01

The subject of this paper is the design of supersonic combustors which will be required in order to achieve the needed reaction rates in a reasonable sized combustor. A fuel additive approach, which is the focus of this research, is the use of pyrophorics to shorten the ignition delay time and to increase the energy density of the fuel. Pyrophoric organometallic compounds may also provide an ignition source and flame stabilization mechanism within the combustor, thus permitting use of hydrocarbon fuels in supersonic combustion systems. Triethylaluminum (TEA) and trimethylaluminum (TMA) were suggested for this application due to their high energy density and reactivity. The objective here is to provide comparative data for the ignition quality, the energy content, and the reaction rates of several different adducts of both TEA and TMA. The results of the experiments indicate the aluminum alkyls and their more stable derivatives reduce the ignition delay and total reaction time to JP-10 jet fuel. Furthermore, the temperature dependence of ignition delay and total reaction time of the blends of the adducts are significantly lower than in neat JP-10. Author (revised)

N94-32877*# Sikorsky Aircraft, Stratford, CT.
INNOVATIVE FABRICATION PROCESSING OF ADVANCED COMPOSITE MATERIALS CONCEPTS FOR PRIMARY AIRCRAFT STRUCTURES Final Report

CHRISTOS KASSAPOGLOU, AL J. DINICOLA, and JACK C. CHOU Feb. 1992 248 p

(Contract NAS1-18799; RTOP 510-02-11)

(NASA-CR-189558; NAS 1.26:189558) Avail: CASI HC A11/MF A03

The autoclave based THERM-X(sub R) process was evaluated by cocuring complex curved panels with frames and stiffeners. The process was shown to result in composite parts of high quality with good compaction at sharp radius regions and corners of intersecting parts. The structural properties of the postbuckled panels fabricated were found to be equivalent to those of conventionally tooled hand laid-up parts. Significant savings in bagging time over conventional tooling were documented. Structural details such as cocured shear

ties and embedded stiffener flanges in the skin were found to suppress failure modes such as failure at corners of intersecting members and skin stiffeners separation. Author

N94-32935 Oak Ridge National Lab., TN.

MATERIALS DEVELOPMENT PROGRAM: CERAMIC TECHNOLOGY PROJECT BIBLIOGRAPHY, 1984-1992

Mar. 1994 61 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract DE-AC05-84OR-21400) (DE94-009297; ORNL/M-3201) Avail: Issuing Activity (Department of Energy (DOE))

The Ceramic Technology for Advanced Heat Engines Project was begun in 1983 to meet the ceramic materials needs of the companion DOE automotive engine program, the Advanced Gas Turbine (AGT) project, and the Heavy Duty Transport (low-heat-rejection, heavy-duty diesel) project. The goal is to develop an industry technology base for reliable and cost effective ceramics for applications in advanced automotive gas turbine and diesel engines. Research areas were identified following extensive input from industry and academia. Majority of research is done by industry (60%); work is also done at colleges and universities, in-house, and at other national laboratories and government agencies. In the beginning, reliability of ceramic components was the key issue. The reliability issues have largely been met and, at the present time, cost is the driving issue, especially in light of the highly cost-sensitive automotive market. Emphasis of the program has now been shifted toward developing cost-effective ceramic components for high-performance engines in the near-term. This bibliography is a compilation of publications done in conjunction with the Ceramic Technology Project since its beginning. Citations were obtained from reports done by participants in the project. We have tried to limit citations to those published and easily located. The end date of 1992 was selected. DOE

N94-33121* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SECOND NASA ADVANCED COMPOSITES TECHNOLOGY CONFERENCE

JOHN G. DAVIS, JR., comp. and HERMAN L. BOHON, comp. Jun. 1992 447 p Conference held in Lake Tahoe, NV, 4-7 Nov. 1991 (Contract RTOP 510-02-13-01) (NASA-CP-3154; L-17106; NAS 1.55:3154) Avail: CASI HC A19/MF A04

The conference papers are presented. The Advanced Composite Technology (ACT) Program is a major multi-year research initiative to achieve a national goal of technology readiness before the end of the decade. Conference papers recorded results of research in the ACT Program in the specific areas of automated fiber placement, resin transfer molding, textile preforms, and stitching as these processes influence design, performance, and cost of composites in aircraft structures. These papers will also be included in the Ninth Conference Proceedings to be published by the Federal Aviation Administration as a separate document.

N94-33122* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DESIGNER'S UNIFIED COST MODEL

WILLIAM T. FREEMAN, L. B. ILCEWICZ, G. D. SWANSON, and T. GUTOWSKI In its Second NASA Advanced Composites Technology Conference p 27-46 Jun. 1992 Avail: CASI HC A03/MF A04

A conceptual and preliminary designers' cost prediction model has been initiated. The model will provide a technically sound method for evaluating the relative cost of different composite structural designs, fabrication processes, and assembly methods that can be compared to equivalent metallic parts or assemblies. The

feasibility of developing cost prediction software in a modular form for interfacing with state of the art preliminary design tools and computer aided design programs is being evaluated. The goal of this task is to establish theoretical cost functions that relate geometric design features to summed material cost and labor content in terms of process mechanics and physics. The output of the designers' present analytical tools will be input for the designers' cost prediction model to provide the designer with a data base and deterministic cost methodology that allows one to trade and synthesize designs with both cost and weight as objective functions for optimization. The approach, goals, plans, and progress is presented for development of COSTADE (Cost Optimization Software for Transport Aircraft Design Evaluation). Author

N94-33123* Analytical Services and Materials, Inc., Hampton, VA.

COINS: A COMPOSITES INFORMATION DATABASE SYSTEM SHAHID SIDDIQI, LOUIS F. VOSTEEN, RALPH EDLOW, and TECK-SENG KWA In NASA Langley Research Center, Second NASA Advanced Composites Technology Conference p 47-55 Jun. 1992

Avail: CASI HC A02/MF A04

An automated data abstraction form (ADAF) was developed to collect information on advanced fabrication processes and their related costs. The information will be collected for all components being fabricated as part of the Advanced Composite Technology (ACT) program and included in a COMposites INFORMATION System (COINS) data base. The aim of the COINS development effort is to provide future airframe preliminary design and fabrication teams with a tool through which production cost can become a deterministic variable in the design optimization process. The effort was initiated by NASA Langley to implement the recommendations of a working group comprised of representatives from the commercial airframe companies. The principal working group recommendation was to reinstitute collection of composite part fabrication data in a format similar to the DOD/NASA Structural Composites Fabrication Guide. The fabrication information collection form was automated with current user friendly computer technology. The new automated form and features that make the form easy to use by an aircraft structural design manufacturing team are described. Author

N94-33124* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPOSITE FUSELAGE SHELL STRUCTURES RESEARCH AT NASA LANGLEY RESEARCH CENTER

JAMES H. STARNES, JR. and MARK J. SHUART In its Second NASA Advanced Composites Technology Conference p 57-83 Jun. 1992

Avail: CASI HC A03/MF A04

Fuselage structures for transport aircraft represent a large portion of both the weight and cost of these aircraft primary structures. Composite materials offer the potential for reducing both the weight and cost of these structures, but only limited studies of the response and failure of composite fuselage structures have been conducted. The research is described which is being conducted and planned at NASA Langley to understand the critical behavior of composite fuselage structures and to validate the structural mechanics methodology being developed for stiffened composite fuselage shell structure subjected to combined internal pressure and mechanical loads. Stiffened shell and curved stiffened panel designs are currently being developed and analyzed, and these designs will be fabricated and then tested to study critical fuselage behavior and to validate structural analysis and design methodology. The research includes studies of the effects of combined internal pressure and mechanical loads on nonlinear stiffened panel and shell behavior, the effects of cutouts and other gradient producing discontinuities on composite shell response, and the effects of local damage on pressure containment and residual strength. Scaling laws are being developed that relate full scale and subscale behavior of composite fuselage shells. Author

N94-33125*# Lockheed Aeronautical Systems Co., Marietta, GA. STRUCTURAL TESTING OF THE TECHNOLOGY INTEGRATION BOX BEAM

C. F. GRIFFIN *In* NASA. Langley Research Center, Second NASA Advanced Composites Technology Conference p 85-97 Jun. 1992
 Avail: CASI HC A03/MF A04

A full scale section of a transport aircraft wing box was designed, analyzed, fabricated, and tested. The wing box section, which was called the technology integration box beam, contained blade stiffened covers and T-stiffened channel spars constructed using graphite-epoxy materials. Covers, spars, and the aluminum ribs were assembled using mechanical fasteners. The box beam was statically tested for several loading conditions to verify the stiffness and strength characteristics of the composite wing design. Failure of the box beam occurred at 125 pct. of design limit load during the combined unbending and torsion ultimate design load test. It appears that the failure initiated at a stiffener runout location in the upper cover which resulted in rupture of the upper cover and portions of both spars. Author

N94-33126*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. TECHNOLOGY INTEGRATION BOX BEAM FAILURE STUDY Status Report

MARK J. SHUART, D. R. AMBUR, D. D. DAVIS, JR., RANDALL C. DAVIS, G. L. FARLEY, C. G. LOTTS, and J. T. WANG *In its* Second NASA Advanced Composites Technology Conference p 99-111 Jun. 1992

Avail: CASI HC A03/MF A04

Composite structures have the potential to be cost effective, structurally efficient primary aircraft structures. As part of the Advanced Composite Technology (ACT) program to exploit this potential for heavily loaded aircraft structures, the design and fabrication of the technology integration box beam (TIBB) was completed. The TIBB is an advanced composite prototype structure for the center wing section of the Lockheed C-130 aircraft. The TIBB was tested for downbending, upbending, torsion, and combined upbending and torsion load conditions to verify the design. The TIBB failed at 83 percent of design ultimate load for the combined upbending and torsion load condition. Current analytical and experimental results are described for a study of the mechanisms that led to the failure of the TIBB. Experimental results include load, strain, and deflection data. An analytical study was conducted of the TIBB structural response. Analytical results include strain and deflection results from a global analysis of the TIBB. Derived from text

N94-33127*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. DEVELOPMENT OF STITCHED/RTM COMPOSITE PRIMARY STRUCTURES

SUSAN M. KULLERD (Lockheed Engineering and Sciences Co., Hampton, VA.) and MARVIN B. DOW *In its* Second NASA Advanced Composites Technology Conference p 115-140 Jun. 1992

Avail: CASI HC A03/MF A04

The goal of the NASA Advanced Composites Technology (ACT) Program is to provide the technology required to gain the full benefit of weight savings and performance offered by composite primary structures. Achieving the goal is dependent on developing composite materials and structures which are damage tolerant and economical to manufacture. Researchers at NASA Langley and Douglas Aircraft Co. are studying stitching reinforcement combined with resin transfer molding (RTM) to create structures meeting the ACT program goals. The research is aimed at materials, processes, and structural concepts for application in both transport wings and fuselages. Empirical guidelines are being established for stitching reinforcement in primary structures and test data are reported in another paper. New data are presented herein from evaluation tests of thick (96 ply) and thin (16 ply) stitched laminates and from selection tests of RTM composite resins. Tension strength, com-

pression strength, and post impact compression strength data are reported. Elements of a NASA Langley program to expand the science base for stitched/RTM composites are discussed.

Derived from text

N94-33128*# Douglas Aircraft Co., Inc., Long Beach, CA. RESIN TRANSFER MOLDING FOR ADVANCED COMPOSITE PRIMARY WING AND FUSELAGE STRUCTURES

ALAN MARKUS *In* NASA. Langley Research Center, Second NASA Advanced Composites Technology Conference p 141-167 Jun. 1992

Avail: CASI HC A03/MF A04

The stitching and resin transfer molding (RTM) processes developed at Douglas Aircraft Co. are successfully demonstrating significant cost reductions with good damage tolerance properties. These attributes were identified as critical to application of advanced composite materials to commercial aircraft primary structures. The RTM/stitching developments, cost analyses, and test results are discussed of the NASA Advanced Composites Technology program. Derived from text

N94-33129*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. TEST AND ANALYSIS RESULTS FOR COMPOSITE

TRANSPORT FUSELAGE AND WING STRUCTURES
 JERRY W. DEATON, SUSAN M. KULLERD, RAM C. MADAN, and VICTOR L. CHEN *In its* Second NASA Advanced Composites Technology Conference p 169-193 Jun. 1992

Avail: CASI HC A03/MF A04

Automated tow placement (ATP) and stitching of dry textile composite preforms followed by resin transfer molding (RTM) are being studied as cost effective manufacturing processes for obtaining damage tolerant fuselage and wing structures for transport aircraft. Data are presented to assess the damage tolerance of ATP and RTM fuselage elements with stitched-on stiffeners from compression tests of impacted three J-stiffened panels and from stiffener pull-off tests. Data are also presented to assess the damage tolerance of RTM wing elements which had stitched skin and stiffeners from impacted single stiffener and three blade stiffened compression tests and stiffener pull-off tests. Derived from text

N94-33130*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. TENSION FRACTURE OF LAMINATES FOR TRANSPORT FUSELAGE. PART 1: MATERIAL SCREENING

T. H. WALKER (Boeing Commercial Airplane Co., Seattle, WA.), W. B. AVERY (Boeing Commercial Airplane Co., Seattle, WA.), L. B. ILCEWICZ (Boeing Commercial Airplane Co., Seattle, WA.), C. C. POE, JR., and C. E. HARRIS *In its* Second NASA Advanced Composites Technology Conference p 197-238 Jun. 1992
 (Contract NAS1-18889)

Avail: CASI HC A03/MF A04

Transport fuselage structures are designed to contain pressure following a large penetrating damage event. Application of composites to fuselage structures requires a data base and supporting analysis on tension damage tolerance. Tests with 430 fracture specimens were used to accomplish the following: (1) identify critical material and laminate variables affecting notch sensitivity, (2) evaluate composite failure criteria, and (3) recommend a screening test method. Variables studied included fiber type, matrix toughness, lamination manufacturing process, and intraply hybridization. The laminates found to have the lowest notch sensitivity were manufactured using automated tow placement. This suggests a possible relationship between the stress distribution and repeatable levels of material inhomogeneity that are larger than found in traditional tape laminates. Laminates with the highest notch sensitivity consisted of toughened matrix materials that were resistant to a splitting phenomena that reduces stress concentrations in load bearing plies. Parameters for conventional fracture criteria were found to increase with the crack length of the smallest notch sizes studied. Most

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materials and laminate combinations followed less than a square root singularity for the largest crack sizes studied. Specimen geometry, notch type, and notch size were evaluated in developing a screening test procedure. Results indicate that a range of notch sizes must be tested to determine notch sensitivity. Author (revised)

N94-33132*# Boeing Commercial Airplane Co., Seattle, WA.

LOCAL DESIGN OPTIMIZATION FOR COMPOSITE TRANSPORT FUSELAGE CROWN PANELS

G. D. SWANSON, L. B. ILCEWICZ, T. H. WALKER, D. GRAESSER, M. TUTTLE, and Z. ZABINSKY *In* NASA. Langley Research Center, Second NASA Advanced Composites Technology Conference p 243-262 Jun. 1992
(Contract NAS1-18889)
Avail: CASI HC A03/MF A04

Composite transport fuselage crown panel design and manufacturing plans were optimized to have projected cost and weight savings of 18 and 45 percent, respectively. These savings are close to those quoted as overall NASA Advanced Composite Technology (ACT) program goals. Three local optimization tasks were found to influence the cost and weight of fuselage crown panels. The effects are summarized of each task and the task associated with a design cost model is described in detail. Studies were performed to evaluate the relationship between manufacturing cost and design details. A design tool was developed to aid in these studies. The development of the design tool included combining cost and performance constraints with a random search optimization algorithm. The resulting software was used in a series of optimization studies that evaluated the sensitivity of design variables, guidelines, criteria, and material selection on cost. The effect of blending adjacent design points in a full scale panel subjected to changing load distributions and local variations was shown to be important. Technical issues and directions for future work were identified. Author (revised)

N94-33133*# Boeing Commercial Airplane Co., Seattle, WA.

COMPOSITE FUSELAGE CROWN PANEL MANUFACTURING TECHNOLOGY

KURTIS WILLDEN, S. METSCHAN, C. GRANT, and T. BROWN *In* NASA. Langley Research Center, Second NASA Advanced Composites Technology Conference p 263-291 Jun. 1992
(Contract NAS1-18889)
Avail: CASI HC A03/MF A04

Commercial fuselage structures contain significant challenges in attempting to save manufacturing costs with advanced composite technology. Assembly issues, materials costs, and fabrication of elements with complex geometry are each expected to drive the cost of composite fuselage structure. Key technologies, such as large crown panel fabrication, were pursued for low cost. An intricate bond panel design and manufacturing concept were selected based on the efforts of the Design Build Team. The manufacturing processes selected for the intricate bond design include multiple large panel fabrication with Advanced Tow Placement (ATP) process, innovative cure tooling concepts, resin transfer molding of long fuselage frames, and use of low cost materials forms. The process optimization for final design/manufacturing configuration included factory simulations and hardware demonstrations. These efforts and other optimization tasks were instrumental in reducing costs by 18 pct. and weight by 45 pct. relative to an aluminum baseline. The qualitative and quantitative results of the manufacturing demonstrations were used to assess manufacturing risks and technology readiness. Author (revised)

N94-33134*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RECENT PROGRESS IN NASA LANGLEY RESEARCH CENTER TEXTILE REINFORCED COMPOSITES PROGRAM

H. BENSON DEXTER, CHARLES E. HARRIS, and NORMAN J. JOHNSTON *In* its Second NASA Advanced Composites Technology Conference p 295-323 Jun. 1992
Avail: CASI HC A03/MF A04

Research was conducted to explore the benefits of textile reinforced composites for transport aircraft primary structures. The objective is to develop and demonstrate the potential of affordable textile reinforced composite materials to meet design properties and damage tolerance requirements of advanced aircraft structural concepts. Some program elements include development of textile preforms, processing science, mechanics of materials, experimental characterization of materials, and development and evaluation of textile reinforced composite structural elements and subcomponents. Textile 3-D weaving, 3-D braiding, and knitting and/or stitching are being compared with conventional laminated tape processes for improved damage tolerance. Through-the-thickness reinforcements offer significant damage tolerance improvements. However, these gains must be weighted against potential loss in in-plane properties such as strength and stiffness. Analytical trade studies are underway to establish design guidelines for the application of textile material forms to meet specific loading requirements. Fabrication and testing of large structural parts are required to establish the potential of textile reinforced composite materials. Author

N94-33135*# Lockheed Aeronautical Systems Co., Marietta, GA.
ADVANCED TEXTILE APPLICATIONS FOR PRIMARY AIRCRAFT STRUCTURES

ANTHONY C. JACKSON, RONALD E. BARRIE, BHARAT M. SHAH, and JAY G. SHUKLA *In* NASA. Langley Research Center, Second NASA Advanced Composites Technology Conference p 325-352 Jun. 1992
(Contract NAS1-18888)
Avail: CASI HC A03/MF A04

Advanced composite primary structural concepts were evaluated for low cost, damage tolerant structures. Development of advanced textile preforms for fuselage structural applications with resin transfer molding and powder epoxy materials are now under development. Author

N94-33136*# Grumman Aerospace Corp., Bethpage, NY.

COMPARISON OF RESIN FILM INFUSION, RESIN TRANSFER MOLDING, AND CONSOLIDATION OF TEXTILE PREFORMS FOR PRIMARY AIRCRAFT STRUCTURE

J. SUAREZ and S. DASTIN *In* NASA. Langley Research Center, Second NASA Advanced Composites Technology Conference p 353-386 Jun. 1992
Avail: CASI HC A03/MF A04

Innovative design concepts and cost effective fabrication processes were developed for damage tolerant primary structures that can perform at a design ultimate strain level of 6000 micro inch/inch. Attention focused on the use of textile high performance fiber reinforcement concepts that provide improved damage tolerance and out-of-plane load capability, low cost resin film infusion (RFI) and resin transfer molding (RTM) processes, and thermoplastic forming concepts. The fabrication of wing 'Y' spars by four different materials and/or processes methods is described: fabricated using IM7 angle interlock 0 to 90 deg woven preforms with + or - 45 deg plies stitched with Toray high strength graphite thread and processed using RFI and 3501-6 epoxy; fabricated using G40-800 knitted/stitched preforms and processed using RFI and 3501-6 epoxy; fabricated using G40-800 knitted/stitched preforms using RTM and Tactix 123/H41 epoxy; and fabricated preforms using AS4(6K)/PEEK 150 g commingled angle interlock 0 to 90 deg woven preforms with + or - 45 deg commingled plies stitched using high strength graphite thread and processed by consolidation. Structural efficiency, processability, and acquisition cost are compared. Author

N94-33137*# Boeing Co., Seattle, WA. Defense and Space Group.
CHARACTERIZATION AND MANUFACTURE OF BRAIDED COMPOSITES FOR LARGE COMMERCIAL AIRCRAFT STRUCTURES

MARK J. FEDRO and KURTIS WILLDEN *In* NASA. Langley Research Center, Second NASA Advanced Composites Technol-

ogy Conference p 387-428 Jun. 1992
(Contract NAS1-18889)
Avail: CASI HC A03/MF A04

Braided composite materials has been recognized as a potential cost effective material form for fuselage structural elements. Consequently, there is a strong need for more knowledge in the design, manufacture, test, and analysis of textile structural composites. Advance braided composite technology is advanced towards applications to a large commercial transport fuselage. The mechanics are summarized of materials and manufacturing demonstration results which were obtained in order to acquire an understanding of how braided composites can be applied to a commercial fuselage. Textile composites consisting of 2-D, 2-D triaxial, and 3-D braid patterns with thermoplastic and two resin transfer molding resin systems were studied. The structural performance of braided composites was evaluated through an extensive mechanical test program. Analytical methods were also developed and applied to predict the following: internal fiber architecture; stiffness; fiber stresses; failure mechanisms; notch effects; and the history of failure of the braided composite specimens. The applicability of braided composites to a commercial transport fuselage was further assessed through a manufacturing demonstration. Author

N94-33165 CSA Engineering, Inc., Palo Alto, CA.
STRUCTURAL INTEGRITY OF INTELLIGENT MATERIALS AND STRUCTURES Report, 1 Jul. 1993 - 31 Jan. 1994
WARREN C. GIBSON and BRYCE L. FOWLER 25 Feb. 1994 44 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract F49620-93-C-0026)
(AD-A278397; AFOSR-94-0166TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Intelligent materials open new avenues to improve performance, reliability, and longevity of future aerospace vehicle structures by allowing the materials themselves to become active elements for multiple system functions. However, the application of intelligent materials and structures has been inhibited because the effects of microstructural interactions between intelligent and host material elements have heretofore not been well characterized. This research implemented and applied three analytical approaches to the study of stress concentrations and cracking around embedded sensor/actuator elements. One was an analytical method based on high-order Ritz functions for accurate representation of steep strain gradients. The second was a conventional finite element approach using very fine meshes, and the third was a finite-element-based computation of energy release rates suitable for predicting crack growth. Among other interesting results, the analyses compared the effects of applied loads with the effects of actuation strains and found that the applied loads were more likely to cause cracking or delamination than actuation. DTIC

N94-33166 Naval Air Warfare Center, Warminster, PA. Vehicle and Crew Systems Technology Dept.
EVALUATION OF THE HUGHES CONVERSION COATING TOUCH-UP PEN Final Report, Jan. - Jun. 1993
JOHN DEITZEL (Jaylords, Inc., Philadelphia, PA.) and STEPHEN J. SPADAFORA 22 Jul. 1993 15 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A278398; NAWCADWAR-93050-60) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Chromate conversion coatings are common surface pretreatments for aluminum substrates on Navy aircraft, weapon platforms, and ground support equipment. While this chromated process performs satisfactorily, future restrictions require the elimination or minimization of chromium emissions from this process. One approach to minimize emissions is through the incorporation of new touch-up procedures. A chemical film touch-up pen developed by Hughes Ground Systems Group offers the potential to provide the required paint adhesion and corrosion protection for aluminum for repair applications. The Naval Air Warfare Center Aircraft Division at

Warminster performed a study of this pen and the following is a description of the evaluation. DTIC

N94-33242 Stanford Univ., CA. Dept. of Mechanical Engineering.
TURBULENT REACTING FLOWS AND SUPERSONIC COMBUSTION Final Report, 15 Feb. 1990 - 14 Oct. 1993
C. T. BOWMAN, R. K. HANSON, M. G. MUNGAL, and W. C. REYNOLDS 15 Dec. 1993 32 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract AF-AFOSR-0151-90)
(AD-A277462; AFOSR-94-0080TR) Avail: CASI HC A03

An experimental and computational investigation of supersonic combustion flows has been carried out. The principal objective of the research was to gain a more fundamental understanding of mixing and chemical reaction in supersonic flows. The research effort comprised three inter-related elements: (1) an experimental study of mixing and combustion in a supersonic plane mixing layer; (2) development of laser-induced fluorescence techniques for time-resolved multidimensional imaging of species concentration, temperature, velocity and pressure; and, (3) analyses and numerical simulations of compressible reacting flows. The specific objectives and results of the research of each of these program elements are summarized in this report. DTIC

N94-33483* National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, OH.
HSR COMBUSTION ANALYTICAL RESEARCH
H. LEE NGUYEN In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 983-996 Apr. 1992
Avail: CASI HC A03/MF A04

Increasing the pressure and temperature of the engines of a new generation of supersonic airliners increases the emissions of nitrogen oxides (NO(x)) to a level that would have an adverse impact on the Earth's protective ozone layer. In the process of evolving and implementing low emissions combustor technologies, NASA LeRC has pursued a combustion analysis code program to guide combustor design processes, to identify potential concepts of the greatest promise, and to optimize them at low cost, with short turnaround time. The computational analyses are evaluated at actual engine operating conditions. The approach is to upgrade and apply advanced computer programs for gas turbine applications. Efforts were made in further improving the code capabilities for modeling the physics and the numerical methods of solution. Then test cases and measurements from experiments are used for code validation. Author

N94-33484* National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, OH.
LERC IN-HOUSE EXPERIMENTAL RESEARCH
VALERIE J. LYONS In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 999-1023 Apr. 1992
Avail: CASI HC A03/MF A04

The topics covered include the following: LeRC in-house experimental research; combustion concepts; schedule for in-house experiments; lean premixed prevaporized combustion; comparisons of low NO(x) lean premixed/prevaporized data; rich burn/quick quench/lean burn (RQL); RQL combustion; fuel rich catalytic combustion; advanced diagnostics; and ceramic matrix liner test rig. Author

N94-33485* General Electric Co., Cincinnati, OH. Aircraft Engines.
LEAN BURN COMBUSTOR TECHNOLOGY AT GE AIRCRAFT ENGINES
WILLARD J. DODDS In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 1027-1042 Apr. 1992
Avail: CASI HC A03/MF A04

This presentation summarizes progress to date at GE Aircraft

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Engines in demonstration of a lean combustion system for the High Speed Civil Transport (HSCT). These efforts were supported primarily by NASA contracts, with the exception of initial size and weight estimates and development of advanced diagnostics which were conducted under GE Independent Research and Development projects. Key accomplishments to date are summarized below.

Author

N94-33512*# Pratt and Whitney Aircraft, West Palm Beach, FL. COMBUSTOR MATERIALS REQUIREMENTS AND STATUS OF CERAMIC MATRIX COMPOSITES

RALPH J. HECHT and ANDREW M. JOHNSON *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1549-1564 Apr. 1992

Avail: CASI HC A03/MF A06

The HSCT combustor will be required to operate with either extremely rich or lean fuel/air ratios to reduce NO(x) emission. NASA High Speed Research (HSR) sponsored programs at Pratt & Whitney (P&W) and GE Aircraft Engines (GEAE) have been studying rich and lean burn combustor design approaches which are capable of achieving the aggressive HSCT NO(x) emission goals. In both of the combustor design approaches under study, high temperature (2400-3000 F) materials are necessary to meet the HSCT emission goals of 3-8 gm/kg. Currently available materials will not meet the projected requirements for the HSCT combustor. The development of new materials is an enabling technology for the successful introduction to service of the HSCT.

Author (revised)

N94-33514*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA. AIRFRAME MATERIALS FOR HSR

THOMAS T. BALES *In its* First Annual High-Speed Research Workshop, Part 3 p 1585-1606 Apr. 1992

Avail: CASI HC A03/MF A06

Vugraphs are presented to show the use of refractory materials for the skin of the High speed Civil Transport (HSCT). Examples are given of skin temperature ranges, failure mode weight distribution, tensile properties as a function of temperature, and components to be constructed from composite materials. The responsibilities of various aircraft companies for specific aircraft components are defined.

Author (revised)

N94-33515*# Boeing Commercial Airplane Co., Seattle, WA. HSCT AIRFRAME MATERIALS: THE BOEING PERSPECTIVE

DONALD L. GRANDE *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1609-1621 Apr. 1992

Avail: CASI HC A03/MF A06

Vugraphs are presented on the effect of cruise Mach number on the maximum takeoff weight of the High Speed Commercial Transport (HSCT). Predictions are made of the service life of the aircraft, and the aging effects of various candidate materials are examined. The objective of the study is to develop and evaluate low cost airplane designs by examining alternate structural, material, and manufacturing concepts, for the purpose of advising material suppliers and NASA on desired materials, product forms, and processing techniques.

Author (revised)

N94-33516*# Douglas Aircraft Co., Inc., Long Beach, CA. HSCT MATERIALS AND STRUCTURES: AN MDC PERSPECTIVE

JAY O. SUTTON *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1625-1641 Apr. 1992

Avail: CASI HC A03/MF A06

The key High Speed Civil Transport (HSCT) features which control the materials selection are discussed. Materials are selected based on weight and production economics. The top-down and bottoms-up approaches to material selection are compared for the Mach 2.4 study baseline aircraft. The key materials and structures

related tasks which remain to be accomplished prior to proceeding with the building of the HSCT aircraft are examined.

Author

N94-33750* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH. NATIONAL AEROSPACE PLANE (Videotape)

Jul. 1990 Videotape: 5 min. 20 sec. playing time, in color, with sound

(NASA-TM-109843; REPT-4002; NONP-VT-94-13533) Avail: CASI VHS A01/BETA A22

This video concentrates on materials being developed and tested at LeRC for possible use in NASP.

CASI

N94-34388*# Alabama Univ., Huntsville, AL. Center for Automation and Robotics. MATERIALS PROCESSING APPARATUS DEVELOPMENT FOR FLUORIDE GLASS Final Report

GUY A. SMITH, SUE KOSTEN, and GARY L. WORKMAN 31 Mar. 1994 26 p

(Contract NAS8-38609)

(NASA-CR-193963; NAS 1.26:193963) Avail: CASI HC A03/MF A01

Fluoride glasses have great potential for optical fiber communications due to the high transmittance when no microcrystallites occur during drawing operations. This work has developed apparatus to test the occurrence of microcrystallites during recrystallization in reduced gravity on the KC-135. The apparatus allows fluoride glass fiber, such as ZBLAN, to be melted and recrystallized during both the low and high g portions the parabolic flight.

Author

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

N94-32867*# Lockheed Aeronautical Systems Co., Marietta, GA. SHEAR FLOW CONTROL OF COLD AND HEATED RECTANGULAR JETS BY MECHANICAL TABS. VOLUME 1: RESULTS AND DISCUSSION

W. H. BROWN and K. K. AHUJA May 1989 357 p

(Contract NAS3-25409)

(NASA-CR-182296-VOL-1; NAS 1.26:182296-VOL-1; LG89ER0059-VOL-1) Avail: CASI HC A16/MF A03

The effects of mechanical protrusions on the jet mixing characteristics of rectangular nozzles for heated and unheated subsonic and supersonic jet plumes were studied. The characteristics of a rectangular nozzle of aspect ratio 4 without the mechanical protrusions were first investigated. Intrusive probes were used to make the flow measurements. Possible errors introduced by intrusive probes in making shear flow measurements were also examined. Several scaled sizes of mechanical tabs were then tested, configured around the perimeter of the rectangular jet. Both the number and the location of the tabs were varied. From this, the best configuration was selected. The conclusions derived were: (1) intrusive probes can produce significant errors in the measurements of the velocity of jets if they are large in diameter and penetrate beyond the jet center; (2) rectangular jets without tabs, compared to circular jets of the same exit area, provide faster jet mixing; and (3) further mixing enhancement is possible by using mechanical tabs.

Author

**N94-32869*# Lockheed Aeronautical Systems Co., Marietta, GA.
SHEAR FLOW CONTROL OF COLD AND HEATED
RECTANGULAR JETS BY MECHANICAL TABS. VOLUME 2:
TABULATED DATA**

W. H. BROWN and K. K. AHUJA May 1989 523 p
(Contract NAS3-25409; RTOP 505-62-00)
(NASA-CR-182296-VOL-2; NAS 1.26:182296-VOL-2; LG89ER0059-VOL-2) Avail: CASI HC A22/MF A04

The effects of mechanical protrusions on the jet mixing characteristics of rectangular nozzles for heated and unheated subsonic and supersonic jet plumes were studied. The characteristics of a rectangular nozzle of aspect ratio 4 without the mechanical protrusions were first investigated. Intrusive probes were used to make the flow measurements. Possible errors introduced by intrusive probes in making shear flow measurements were also examined. Several scaled sizes of mechanical tabs were then tested, configured around the perimeter of the rectangular jet. Both the number and the location of the tabs were varied. From this, the best configuration was selected. This volume contains tabulated data for each of the data runs cited in Volume 1. Baseline characteristics, mixing modifications (subsonic and supersonic, heated and unheated) and miscellaneous charts are included. Author

**N94-32871*# Vigyan Research Associates, Inc., Hampton, VA.
COMPUTATION OF THREE-DIMENSIONAL COMPRESSIBLE
BOUNDARY LAYERS TO FOURTH-ORDER ACCURACY ON
WINGS AND FUSELAGES Final Report**

VENKIT IYER Jan. 1990 275 p
(Contract NAS1-18585; RTOP 505-60-31-05)
(NASA-CR-4269; NAS 1.26:4269) Avail: CASI HC A12/MF A03

A solution method, fourth-order accurate in the body-normal direction and second-order accurate in the stream surface directions, to solve the compressible 3-D boundary layer equations is presented. The transformation used, the discretization details, and the solution procedure are described. Ten validation cases of varying complexity are presented and results of calculation given. The results range from subsonic flow to supersonic flow and involve 2-D or 3-D geometries. Applications to laminar flow past wing and fuselage-type bodies are discussed. An interface procedure is used to solve the surface Euler equations with the inviscid flow pressure field as the input to assure accurate boundary conditions at the boundary layer edge. Complete details of the computer program used and information necessary to run each of the test cases are given in the Appendix. Author

**N94-32872*# Georgia Inst. of Tech., Atlanta, GA.
ENHANCEMENT OF MIXING IN A RECTANGULAR JET BY
MECHANICAL TABS**

W. H. BROWN and K. K. AHUJA Apr. 1990 86 p
(Contract NAG3-1062; RTOP 505-62-00)
(NASA-CR-185207; A-8402; NAS 1.26:185207) Avail: CASI HC A05/MF A01

This effort was conducted to obtain additional test data/configurations required to better understand the effects of tab length and width on jet mixing enhancement for a rectangular nozzle. The configurations tested were a six-tab configuration defined by NASA, a full-height tab configuration, and two-tab configurations with selected tab lengths and widths. Additional test data were also required for all candidate configurations to better interpret the data. Test data from this effect are presented. On the basis of these data, the following general observations were noted: The six-tab rectangular nozzle configuration provided a lower peak velocity than either the two-tab or four-tab configuration; and the rectangular nozzle with a full-height tab had about the same peak velocity as the two-tab configuration; however, the full-height tab configuration had a somewhat lower centerline velocity. Author

**N94-32883*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, OH.
FLUTTER ANALYSIS OF A SUPERSONIC CASCADE IN TIME**

DOMAIN USING AN ADI EULER SOLVER

T. S. R. REDDY (Toledo Univ., OH.), M. A. BAKHLE (Toledo Univ., OH.), and D. L. HUFF Apr. 1992 25 p
(Contract RTOP 535-03-01)
(NASA-TM-105625; E-6966; NAS 1.15:105625) Avail: CASI HC A03/MF A01

The aeroelastic stability of a two-dimensional cascade oscillating in supersonic axial flow is analyzed in the time domain. The aeroelastic model consists of a single degree of freedom typical section structural model for each blade of the cascade and an unsteady two-dimensional cascade aerodynamic model based on the Euler equations. The Euler equations are solved using a time accurate Alternating Direction Implicit (ADI) solution scheme. The aeroelastic equations are integrated in time. The effect of interblade phase angle is included in the aeroelastic analysis by an appropriate choice of initial and boundary conditions. Flutter predictions are obtained from the time response of a flat plate cascade in single degree of freedom pitching motion. The results correlate well with those obtained from a separate frequency domain flutter analysis for all values of interblade phase angles considered. Flutter results are then presented for cascades having airfoil sections representative of a supersonic throughflow fan. The validity of the time integration method for a cascade of airfoils at various interblade phase angles is demonstrated. Author

N94-32929*# Akron Univ., OH.

**A PROCEDURE FOR 3-D CONTACT STRESS ANALYSIS OF
SPIRAL BEVEL GEARS Final Report**

A. KUMAR and G. BIBEL Mar. 1994 87 p
(Contract NAG3-1476; DA PROJ. 1L1-62211-A-47-A; RTOP 505-62-10)
(NASA-CR-194472; E-8613; NAS 1.26:194472; ARL-CR-72) Avail: CASI HC A05/MF A01

Contact stress distribution of spiral bevel gears using nonlinear finite element static analysis is presented. Procedures have been developed to solve the nonlinear equations that identify the gear and pinion surface coordinates based on the kinematics of the cutting process and orientate the pinion and the gear in space to mesh with each other. Contact is simulated by connecting GAP elements along the intersection of a line from each pinion point (parallel to the normal at the contact point) with the gear surface. A three dimensional model with four gear teeth and three pinion teeth is used to determine the contact stresses at two different contact positions in a spiral bevel gearset. A summary of the elliptical contact stress distribution is given. This information will be helpful to helicopter and aircraft transmission designers who need to minimize weight of the transmission and maximize reliability. Author (revised)

**N94-32969*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, OH.
INSTITUTE FOR COMPUTATIONAL MECHANICS IN
PROPULSION (ICOMP) Annual Report No. 8, 1993**

CHARLES E. FEILER, ed. Apr. 1994 91 p
(Contract NCC3-233; RTOP 505-90-5K)
(NASA-TM-106542; ICOMP-94-01; E-8686; NAS 1.15:106542) Avail: CASI HC A05/MF A01

The Institute for Computational Mechanics in Propulsion (ICOMP) is operated by the Ohio Aerospace Institute (OAI) and the NASA Lewis Research Center in Cleveland, Ohio. The purpose of ICOMP is to develop techniques to improve problem-solving capabilities in all aspects of computational mechanics related to propulsion. This report describes the accomplishments and activities at ICOMP during 1993. Author

**N94-33020*# National Aeronautics and Space Administration.
Langley Research Center, Hampton, VA.**

**IMPLEMENTATION OF A VIBRATIONALLY LINKED CHEMICAL
REACTION MODEL FOR DSMC**

A. B. CARLSON and GRAEME A. BIRD Apr. 1994 11 p
(Contract RTOP 232-01-04-04)

12 ENGINEERING

(NASA-TM-109109; NAS 1.15:109109) Avail: CASI HC A03/MF A01

A new procedure closely linking dissociation and exchange reactions in air to the vibrational levels of the diatomic molecules has been implemented in both one- and two-dimensional versions of Direct Simulation Monte Carlo (DSMC) programs. The previous modeling of chemical reactions with DSMC was based on the continuum reaction rates for the various possible reactions. The new method is more closely related to the actual physics of dissociation and is more appropriate to the particle nature of DSMC. Two cases are presented: the relaxation to equilibrium of undissociated air initially at 10,000 K, and the axisymmetric calculation of shuttle forebody heating during reentry at 92.35 km and 7500 m/s. Although reaction rates are not used in determining the dissociations or exchange reactions, the new method produces rates which agree astonishingly well with the published rates derived from experiment. The results for gas properties and surface properties also agree well with the results produced by earlier DSMC models, equilibrium air calculations, and experiment. Author

N94-33118* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STRUCTURAL DAMPING STUDIES AT CRYOGENIC TEMPERATURES

CLARENCE P. YOUNG, JR. (North Carolina Univ., Raleigh.) and RALPH D. BUEHRLE May 1994 34 p
(Contract RTOP 505-59-54-01)

(NASA-TM-109073; NAS 1.15:109073) Avail: CASI HC A03/MF A01

Results of an engineering study to measure changes in structural damping properties of two cryogenic wind tunnel model systems and two metallic test specimens at cryogenic temperatures are presented. Data are presented which indicate overall, a trend toward reduced structural damping at cryogenic temperatures (-250 degrees F) when compared with room temperature damping properties. The study was focused on structures and materials used for model systems tested in the National Transonic Facility (NTF). The study suggests that the significant reductions in damping at extremely cold temperatures are most likely associated with changes in mechanical joint compliance damping rather than changes in material (solid) damping. Author

N94-33160* Naval Postgraduate School, Monterey, CA.
AN ANALYSIS OF CELLULAR TELEPHONE AND INMARSAT SYSTEMS FOR PROVIDING RADIO DATA LINK COMPUTER COMMUNICATIONS FOR US NAVY VESSELS M.S. Thesis

DAVID L. COOPER, JR. Dec. 1993 69 p
(AD-A278143) Avail: CASI HC A04/MF A01

This thesis examines radio frequency data link computer communications systems with emphasis on their potential application to ship/shore communications. Covered are two systems that experts believe hold the most promise for DOD application, International Maritime Satellite (INMARSAT) and cellular radiotelephones. An analysis of system capabilities, cost, and future potential is performed for each, and then the two systems are compared. In addition, a thorough discussion of the security issues for each system and final conclusions/recommendations are presented. The conclusions suggest that increased cellular radiotelephone usage vice INMARSAT by fleet units would optimize fleet readiness and improve supply system performance. Based on these conclusions, this author's recommendation is that all Navy ships be equipped with a cellular telephone system, while all aircraft carriers and amphibious aircraft carriers be equipped with both cellular and INMARSAT systems. DTIC

N94-33385* Applied Research Associates, Inc., Panama City, FL.
HALON 1211 REPLACEMENT AGENT EVALUATION-PERFLUOROHXANE AND HALOTRON I Final Report
MICHAEL A. ROCHEFORT, BILLY R. DEES, and CHARLES W. RISINGER Nov. 1993 37 p

(Contract F08635-93-C-0020)

(AD-A278194; WL-TR-93-3520) Avail: CASI HC A03/MF A01

This test program quantified the fire extinguishment performance of the candidate Halon 1211 replacement agents, perfluorohexane and Halotron I. Both of these agents were tested head-to-head with Halon 1211 for several typical aircraft fire scenarios. The following tests were conducted: agent throw-range tests, dry-pool fire extinguishment tests, three-dimensional inclined plane running fuel fire tests, simulated engine-nacelle running-fuel fire tests, and simulated wheel-well fires involving hydraulic fluid. All tests except the wheel well fire used JP-4 as the fuel. Amerex Model 600 (150-pound wheeled) extinguishers were used to dispense the agent in each test. DTIC

N94-33391 DynaFlow, Inc., Columbus, OH.

METHOD FOR TRANSITION PREDICTION IN HIGH-SPEED BOUNDARY LAYERS, PHASE 2 Final Report, 27 Sep. 1990 - 27 Sep. 1993

T. HERBERT, G. K. STUCKERT, and N. LIN Sep. 1993 102 p
Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract F33615-90-C-3009)

(AD-A277563; WL-TR-93-3097-PHASE-2) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The parabolized stability equations (PSE) are a new and more reliable approach to analyzing the stability of streamwise varying flows such as boundary layers. This approach has been previously validated for idealized incompressible flows. Here, the PSE are formulated for highly compressible flows in general curvilinear coordinates to permit the analysis of high-speed boundary-layer flows over fairly general bodies. Vigorous numerical studies are carried out to study convergence and accuracy of the linear-stability code LSH and the linear/nonlinear PSE code PSH. Physical interfaces are set up to analyze the $M = 8$ boundary layer over a blunt cone calculated by using a thin-layer Navier Stokes (TNLS) code and the flow over a sharp cone at angle of attack calculated using the AFWAL parabolized Navier-Stokes (PNS) code. While stability and transition studies at high speeds are far from routine, the method developed here is the best tool available to research the physical processes in high-speed boundary layers. DTIC

N94-33396 Illinois Inst. of Tech., Chicago, IL. Fluid Dynamics Research Center.

CONTROL AND MANAGEMENT OF UNSTEADY AND TURBULENT FLOWS Final Report, Apr. 1990 - Dec. 1993

H. NAGIB, M. ACHARYA, T. CORKE, C. WARK, and D. WILLIAMS Dec. 1993 36 p
Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract AF-AFOSR-0173-90)

(AD-A278474; AFOSR-94-0190TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Active input of tuned and detuned two dimensional and oblique modes in a layer was found to lead to the growth of near-subharmonic modes as well as numerous sum and difference modes, thereby emulating 'natural' transition. Acoustic receptivity of laminar boundary layers with nonlocalized low-amplitude periodic waviness was experimentally investigated and compared favorably to theoretical predictions. Closed loop excitation of axisymmetric and azimuthal modes in a free round jet were used to reveal the character of high Reynolds number transition (i.e., supercritical Hopf bifurcation) and to study mode selection and switching. Suction and blowing were shown to be capable of controlling the asymmetric flow about the forebodies of aircraft and missiles and the experiments indicate that the suction bleed coefficient must increase like the 3.9 power of the velocity to balance the effects of geometric instability at the tip. The effects of yaw on such asymmetries were also documented. A strategy to suppress the dynamic-stall vortex over a range of operating parameters, using controlled leading-edge suction to prevent accumulation of reverse-flowing fluid, was successfully developed from a study of the mechanisms responsible for the

evolution of the vortex. The National Diagnostic Facility was completed and several collaborative experiments are scheduled during 1994. DTIC

N94-33399 Trident International, Inc., Orlando, FL.
SINGLE CRYSTAL FACEPLATE EVALUATION Final Report,
 Nov. 1990 - Oct. 1993

A. R. TUCKER and H. J. KINDL 25 Oct. 1993 175 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
 (Contract N61339-90-C-0047)
 (AD-A277922) Avail: CASI HC A08

The Naval Training Systems Center developed single crystal faceplates which held promise for providing a significantly improved life span over conventional power phosphor cathode ray tubes (CRT) while maintaining acceptable resolution and light output characteristics. Single crystal faceplates being evaluated are composed of yttrium aluminum garnet (YAG) with an epitaxial cerium phosphor layer grown on the YAG substrate producing a cathodoluminescent material (CE:YAG). The single crystal nature of these faceplates should allow higher resolution (no phosphor grains) and higher thermal conductivity. DTIC

N94-33609# National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, OH.

IMPROVEMENTS IN SPIRAL-BEVEL GEARS TO REDUCE NOISE AND INCREASE STRENGTH

DAVID G. LEWICKI, ROBERT F. HANDSCHUH, ZACHARY S. HENRY, and FAYDOR L. LITVIN May 1994 8 p Proposed for presentation at the 1994 International Gearing Conference, England, 7-9 Sep. 1994; sponsored by the University of Newcastle Upon Tyne

(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-62-10)
 (NASA-TM-106613; E-8896; NAS 1.15:106613; ARL-TR-459) Avail: CASI HC A02/MF A01

Advanced-design spiral-bevel gears were tested in an OH-58D helicopter transmission using the NASA 500 hp Helicopter Transmission Test Stand. Four different gear designs were tested. The four designs tested were the current design of the OH-58D transmission, a higher-strength design the same as the current but with an increased fillet radius to reduce gear tooth bending stress, and two versions of a lower-noise design the same as the high-strength but with modified tooth geometry to reduce transmission error and noise. Noise, vibration, and tooth strain tests were performed and significant gear stress and noise reductions were achieved.

Author

N94-33618# Aerospace Medical Research Labs., Wright-Patterson AFB, OH.

LABORATORY AND IN-FLIGHT EXPERIMENTS TO EVALUATE 3-D AUDIO DISPLAY TECHNOLOGY

MARK ERICSON, RICHARD MCKINLEY, MARION KIBBE, and DANIEL FRANCIS In NASA. Johnson Space Center, Seventh Annual Workshop on Space Operations Applications and Research (SOAR 1993), Volume 2 p 371-377 Jan. 1994
 Avail: CASI HC A02/MF A03

Laboratory and in-flight experiments were conducted to evaluate 3-D audio display technology for cockpit applications. A 3-D audio display generator was developed which digitally encodes naturally occurring direction information onto any audio signal and presents the binaural sound over headphones. The acoustic image is stabilized for head movement by use of an electromagnetic head-tracking device. In the laboratory, a 3-D audio display generator was used to spatially separate competing speech messages to improve the intelligibility of each message. Up to a 25 percent improvement in intelligibility was measured for spatially separated speech at high ambient noise levels (115 dB SPL). During the in-flight experiments, pilots reported that spatial separation of speech communications provided a noticeable improvement in intelligibility. The use of 3-D audio for target acquisition was also investigated. In the laboratory, 3-D audio enabled the acquisition of visual targets in about two

seconds average response time at 17 degrees accuracy. During the in-flight experiments, pilots correctly identified ground targets 50, 75, and 100 percent of the time at separation angles of 12, 20, and 35 degrees, respectively. In general, pilot performance in the field with the 3-D audio display generator was as expected, based on data from laboratory experiments. Author (revised)

N94-33756# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
 School of Engineering.

DYADIC WAVELET FEATURES FOR ISOLATED WORD SPEAKER DEPENDENT SPEECH RECOGNITION M.S.

Thesis

STEPHEN AINGE Mar. 1994 139 p
 (AD-A278492; AFIT/GE/ENG/94M-03) Avail: CASI HC A07/MF A02

This research examines the use of dyadic wavelet features for the recognition of speaker dependent isolated word speech. The features were generated using three different wavelet filters: Daubechies 4 coefficient (Db4), Daubechies 20 coefficient (Db20), and a 31 coefficient cubic spline; and three different window lengths: 16 ms, 8 ms, and 4 ms. The accuracy of the standard and over-sampled dyadic wavelet methods were compared. The over-sampled dyadic wavelet method using the Db4 scaling function, with a maximum accuracy of 65.5%, was found to be the most accurate of the wavelet methods tested. The accuracy of this over-sampled dyadic Db4 wavelet method was compared to the accuracy of three Fourier feature methods: octave frequency bandwidth, equal bandwidth, and Mel scaled bandwidth features. The dyadic wavelet methods did not perform as well as the Fourier methods. The maximum accuracy obtained for the wavelet methods was 65.5%, compared to the maximum accuracy of the octave bandwidth feature Fourier method of 85.6%. The combination of wavelet features and Fourier features was tested. The order of magnitude of the covariance matrices of each set were equalized and the resulting feature vector set classified. It was found that the recognition accuracy of the wavelet plus Fourier feature vectors, 74.0%, was lower than the recognition accuracy of the Fourier-only feature vectors, 84.5%. The inclusion of the wavelet features added information to the system that reduced the recognition effectiveness of the Fourier features. DTIC

N94-33768# Trident International, Inc., Orlando, FL.
HIGH DEFINITION TV PROJECTION VIA SINGLE CRYSTAL FACEPLATE TECHNOLOGY Final Report

H. J. KINDL and THOMAS ST. JOHN 25 Mar. 1993 182 p
 (Contract N61339-92-C-0014)
 (AD-A277850) Avail: CASI HC A09/MF A02

Single crystal phosphor faceplates are epitaxial phosphors grown on crystalline substrates with the advantages of high light output, resolution, and extended operational life. Single crystal phosphor faceplate industrial technology in the United States is capable of providing a faceplate appropriate to the projection industry of up to four (4) inches in diameter. Projection systems incorporating cathode ray tubes utilizing single crystal phosphor faceplates will produce 1500 lumens of white light with 1000 lines of resolution, non-interlaced. This 1500 lumen projection system will meet all of the currently specified luminance and resolution requirements of Visual Display systems for flight simulators. Significant logistic advantages accrue from the introduction of single crystal phosphor faceplate CRT's. Specifically, the full performance life of a CRT is expected to increase by a factor of five (5); ie, from 2000 to 10,000 hours of operation. There will be attendant reductions in maintenance time, spare CRT requirements, system down time, etc. The increased brightness of the projection system will allow use of lower gain, lower cost simulator screen material. Further, picture performance characteristics will be more balanced across the full simulator. DTIC

N94-33885# Arizona State Univ., Tempe, AZ. Dept. of Mechanical and Aerospace Engineering.

PHYSICAL DESCRIPTION OF BOUNDARY-LAYER

TRANSITION: EXPERIMENTAL EVIDENCE

WILLIAM S. SARIC *In* AGARD, Special Course on Progress in Transition Modelling 51 p Apr. 1994
(Contract NAG1-1111; AF-AFOSR-0234-90)
Copyright Avail: CASI HC A04/MF A03

The problems of understanding the origins of turbulent flow and transition to turbulent flow are the most important unsolved problems of fluid mechanics and aerodynamics. It is well known that the stability, transition, and turbulent characteristics of bounded shear layers are fundamentally different from those of free shear layers. Likewise, the stability, transition, and turbulent characteristics of open systems are fundamentally different from those of closed systems. Because of the influence of indigenous disturbances, surface geometry and roughness, sound, heat transfer, and ablation, it is not possible to develop general prediction schemes for transition location and the nature of turbulent structures in boundary-layer flows. At the present time no mathematical model exists that can predict the transition Reynolds number on a flat plate. The recent progress in this area is encouraging, in that a number of distinct transition mechanisms have been found experimentally. The theoretical work finds them to be amplitude and Reynolds-number dependent. The theory remains rather incomplete with regard to predicting transition. Amplitude and spectral characteristics of the disturbances inside the laminar viscous layer strongly influence which type of transition occurs. The major need in this area is to understand how freestream disturbances are entrained into the boundary layer, i.e., to answer the question of receptivity. We refer receptivity to the mechanism(s) that cause freestream disturbances to enter the boundary layer and create the initial amplitudes for unstable waves.

Derived from text

**N94-33897*# High Technology Corp., Hampton, VA.
ACOUSTIC RECEPTIVITY OF COMPRESSIBLE BOUNDARY
LAYERS: RECEPTIVITY BY WAY OF SURFACE-
TEMPERATURE VARIATIONS**

MEELAN CHOUDHARI Jun. 1994 36 p
(Contract NAS1-20059; RTOP 505-59-50-01)
(NASA-CR-4599; NAS 1.26:4599) Avail: CASI HC A03/MF A01

The Goldstein-Ruban theory has been extended within the framework of Zavol'skii et al. to study the acoustic receptivity of compressible boundary layers. We consider the receptivity produced in a region of localized, small-amplitude variation in the surface temperature and compare it with the receptivity that is induced through a similar mechanism by a variation in the suction velocity at the surface. It is found that the orientation of the acoustic wave can have a significant impact on the receptivity process, with the maximum receptivity at a given sound-pressure level being produced by upstream oriented acoustic waves. At sufficiently low Mach numbers, the variation of receptivity with the acoustic-wave orientation can be predicted analytically and is the same for both surface suction and surface heating. However, as a result of the acoustic refraction across the mean boundary layer, the above dependence can become rather complex and, also, dependent on the type of surface nonuniformity. The results also suggest that the receptivity caused by temperature nonuniformities may turn out to be more significant than that produced by the mean-flow perturbations associated with strip suction.

Author

**N94-33941*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, OH.**

**VISUALIZATION OF SECONDARY FLOW DEVELOPMENT IN
HIGH ASPECT RATIO CHANNELS WITH CURVATURE**

MICHAEL L. MEYER and JAMES E. GIULIANI Jun. 1994 14 p
Presented at the 30th Joint Propulsion Conference, Indianapolis, IN, 27-29 Jun. 1994; sponsored by AIAA, ASME, SAE, and ASEE
(Contract RTOP 232-01-0A)
(NASA-TM-106658; E-8972; NAS 1.15:106658; AIAA PAPER 94-2979) Avail: CASI HC A03/MF A01

The results of an experimental project to visually examine the secondary flow structure that develops in curved, high aspect-ratio rectangular channels are presented. The results provide insight into

the fluid dynamics within high aspect ratio channels. A water flow test rig constructed out of plexiglass, with an adjustable aspect ratio, was used for these experiments. Results were obtained for a channel geometry with a hydraulic diameter of 10.6 mm (0.417 in.), an aspect ratio of 5.0, and a hydraulic radius to curvature radius ratio of 0.0417. Flow conditions were varied to achieve Reynolds numbers up to 5,100. A new particle imaging velocimetry technique was developed which could resolve velocity information from particles entering and leaving the field of view. Time averaged secondary flow velocity vectors, obtained using this velocimetry technique, are presented for 30 degrees, 60 degrees, and 90 degrees into a 180 degrees bend and at a Reynolds number of 5,100. The secondary flow results suggest the coexistence of both the classical curvature induced vortex pair flow structure and the eddies seen in straight turbulent channel flow.

Author (revised)

**N94-33954*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, OH.**

**COMPARISON OF TRANSMISSION ERROR PREDICTIONS
WITH NOISE MEASUREMENTS FOR SEVERAL SPUR AND
HELICAL GEARS**

DONALD R. HOUSER (Ohio State Univ., Columbus.), FRED B. OSWALD, MARK J. VALCO, RAYMOND J. DRAGO, and JOSEPH W. LENSKE, JR. Jun. 1994 12 p Presented at the 30th Joint Propulsion Conference, Indianapolis, IN, 27-29 Jun. 1994; sponsored by AIAA, ASME, SAE, and ASEE
(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-62-36)
(NASA-TM-106647; E-8954; NAS 1.15:106647; ARL-TR-493; AIAA PAPER 94-3366) Avail: CASI HC A03/MF A01

Measured sound power data from eight different spur, single and double helical gear designs are compared with predictions of transmission error by the Load Distribution Program. The sound power data was taken from the recent Army-funded Advanced Rotorcraft Transmission project. Tests were conducted in the NASA gear noise rig. Results of both test data and transmission error predictions are made for each harmonic of mesh frequency at several operating conditions. In general, the transmission error predictions compare favorably with the measured noise levels.

Author

**N94-33960*# National Aeronautics and Space Administration.
Lewis Research Center, Cleveland, OH.**

**ENGINE SEAL TECHNOLOGY REQUIREMENTS TO MEET
NASA'S ADVANCED SUBSONIC TECHNOLOGY PROGRAM
GOALS**

BRUCE M. STEINETZ and ROBERT C. HENDRICKS Jun. 1994 13 p Presented at the 30th Joint Propulsion Conference, Indianapolis, IN, 27-29 Jun. 1994; sponsored by AIAA, ASME, SAE, and ASEE
(Contract RTOP 505-630-5B)
(NASA-TM-106582; E-8842; NAS 1.15:106582; AIAA PAPER 94-2698) Avail: CASI HC A03/MF A01

Cycle studies have shown the benefits of increasing engine pressure ratios and cycle temperatures to decrease engine weight and improve performance of commercial turbine engines. NASA is working with industry to define technology requirements of advanced engines and engine technology to meet the goals of NASA's Advanced Subsonic Technology Initiative. As engine operating conditions become more severe and customers demand lower operating costs, NASA and engine manufacturers are investigating methods of improving engine efficiency and reducing operating costs. A number of new technologies are being examined that will allow next generation engines to operate at higher pressures and temperatures. Improving seal performance - reducing leakage and increasing service life while operating under more demanding conditions - will play an important role in meeting overall program goals of reducing specific fuel consumption and ultimately reducing direct operating costs. This paper provides an overview of the Advanced Subsonic Technology program goals, discusses the motivation for advanced seal development, and highlights seal technology requirements to meet future engine performance goals.

Author

N94-34148*# North Dakota Univ., Grand Forks.

PREDICTION OF CONTACT PATH AND LOAD SHARING IN SPIRAL BEVEL GEARS Final Report

GEORGE D. BIBEL, KARUNA TIKU, and ASHOK KUMAR Apr. 1994 116 p

(Contract NAG3-1476; DA PROJ. 1L1-62211-A-47-A; RTOP 505-62-36)

(NASA-CR-195305; E-8711; NAS 1.26:195305; ARL-CR-146) Avail: CASI HC A06/MF A02

A procedure is presented to perform a contact analysis of spiral bevel gears in order to predict the contact path and the load sharing as the gears roll through mesh. The approach utilizes recent advances in automated contact methods for nonlinear finite element analysis. A sector of the pinion and gear is modeled consisting of three pinion teeth and four gear teeth in mesh. Calculation of the contact force and stresses through the gear meshing cycle are demonstrated. Summary of the results are presented using three dimensional plots and tables. Issues relating to solution convergence and requirements for running large finite element analysis on a supercomputer are discussed. Author (revised)

N94-34178*# Osaka Univ., Toyonaka (Japan).

ACTIVE CONTROL OF VANELESS DIFFUSER ROTATING STALL

YOSHIKI YOSHIDA, YOSHINOBU TSUJIMOTO, TOMOHIRO TATEISHI, and HIROMU TSURUSAKI In NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 15-27 Jan. 1994 Sponsored by Ministry of Education

Avail: CASI HC A03/MF A04

Experiments were carried out to study the feasibility of active stabilization of vaneless diffuser rotating stalls. Pressure fluctuation at the diffuser inlet was monitored and used to control the rotating stall. AC control flow, which is produced by a load speaker, was introduced into the diffuser at the inlet. It is shown that the rotating stall can be suppressed when the phase of the control flow has a certain relation with the phase of the rotating stall. By considering the energy flux due to the AC control flow, it is shown that the rotating stall is suppressed when the control flow has the phase such that the energy is subtracted out from the diffuser flow. Discussions are made on the relations between the energy flux and the amplitude of the pressure fluctuation due to the rotating stalls.

Derived from text

N94-34181*# Texas A&M Univ., College Station.

ECCENTRICITY EFFECTS UPON THE FLOW FIELD INSIDE A WHIRLING ANNULAR SEAL

GERALD L. MORRISON, ROBERT E. DEOTTE, JR., PURANDAR G. DAS, and H. DAVIS THAMES In NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 101-112 Jan. 1994

Avail: CASI HC A03/MF A04

The flow field inside a whirling annular seal operating at a Reynolds number of 24,000 and a Taylor number of 6600 has been measured using a 3-D laser Doppler anemometer system. Two eccentricity ratios were considered, 0.10 and 0.50. The seal has a diameter of 164 mm, is 37.3 mm long, and has a clearance of 1.27 mm. The rotor was mounted eccentrically on the shaft such that the whirl ratio is 1.0 and the rotor follows a circular orbit. The mean axial velocity is not uniform around the circumference of the seal; near the inlet a region characterized by high velocity of the seal. By the exit, another region of high axial velocity is not uniform around the circumference of the seal; near the inlet a region characterized by high velocity of the seal. By the exit, another region of high axial velocity has developed, this time on the suction side of the seal. The magnitude and azimuthal distance of the migration increased with increasing whirl amplitude (eccentricity). Throughout the seal length, the azimuthal mean velocity varied inversely with the mean axial velocity. Increasing the whirl amplitude did not increase the magnitude of the azimuthal velocity at the seal exit. Author (revised)

N94-34185*# Heriot-Watt Univ., Edinburgh (Scotland).

WHIRL MEASUREMENTS ON LEAKAGE FLOWS IN TURBOMACHINE MODELS

A. J. ADDLESEE, D. ALTIPARMAK, and S. PAN In NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 167-178 Jan. 1994 Sponsored in part by Weir Pumps Ltd.

Avail: CASI HC A03/MF A04

The beneficial effects claimed for whirl control devices demonstrate that the dynamic behavior of rotors is influenced by the fluid whirl in shaft and balance drum seals. The present paper reports results from two series of experiments, the first on the factors affecting the whirl at the seal inlet, and the second on the variation of whirl velocity along the seal. In both cases the LDA measurement technique required the clearance between the fixed and rotating parts of the models to be substantially greater than occurs in real machines, but the results are indicative nevertheless. Experimental and theoretical results are given for the radial distribution of whirl velocity in the gap between impeller shroud and pump casing. Results of tests with modified stator surfaces are also shown. This work leads naturally into the second series of experiments where some preliminary measurements of velocity distribution in the clearance between a fixed stator and a rotating shaft are reported for a range of inlet whirl conditions. Author

N94-34186*# Massachusetts Inst. of Tech., Cambridge.

ROTORDYNAMIC FORCES IN LABYRINTH SEALS: THEORY AND EXPERIMENT

KNOX T. MILLSAPS and MANUEL MARTINEZ-SANCHEZ In NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 179-207 Jan. 1994

Avail: CASI HC A03/MF A04

A theoretical and experimental investigation of the aerodynamic forces generated by a single gland labyrinth seal executing a simultaneous spinning/whirling motion has been conducted. A lumped parameter model for a single gland seal with coupling to an upstream cavity with leakage is developed along with an appropriate solution technique. From this theory, it is shown that the presence of the upstream cavity can, in some cases, augment the cross-stiffness and direct damping by a factor of four. The parameters that govern the coupling are presented along with predictions on their influence. A simple uncoupled model is used to identify the mechanisms responsible for cross force generation. This reduced system is nondimensionalized and the physical significance of the reduced parameters is discussed. Closed form algebraic formulas are given for some simple limiting cases. It is also shown that the total cross-force predicted by the uncoupled model can be represented as the sum of an ideal component due to an inviscid flow with entry swirl and a viscous part due to the change in swirl created by friction inside the gland. The frequency dependent ideal part is solely responsible for the rotordynamic direct damping. The facility designed and built to measure these frequency dependent forces is described. Experimental data confirm the validity and usefulness of this ideal/viscous decomposition. A method for calculating the damping coefficients based on the force decomposition using only the static measurements is presented. Experimental results supporting the predicted cross force augmentation due to the effect of upstream coupling are presented. Author

N94-34188*# Kobe Univ. (Japan).

AN EXPERIMENTAL STUDY OF DYNAMIC CHARACTERISTICS OF LABYRINTH SEAL

TAKUZO IWATSUBO, KOJI FUKUMOTO, and HIDEYUKI MOCHIDA In NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 219-237 Jan. 1994

Avail: CASI HC A03/MF A04

The fluid force due to labyrinth seal sometimes makes the turbomachineries unstable under higher rotating speed, higher pressure and higher power. Therefore, it is important to predict the

magnitude and the direction of the fluid force and to evaluate the stability of the rotor system in design process. This paper shows the experimental results of the fluid force induced by a straight labyrinth seal and the rotordynamic coefficients calculated from the fluid force. Influences of the number of fins under the rotating speed, whirling speed, inlet pressure, and inlet tangential velocity are mainly investigated on a stability of the rotor system. The results show that increase of the number of fins makes the fluid force small and the rotor system stable, an increase of inlet pressure makes the fluid forces large and an increase of inlet tangential velocity makes the rotor system unstable. Author

N94-34191* Bently Rotor Dynamics Research Corp., Minden, NV.

EXPERIMENTAL AND ANALYTICAL STUDY ON FLUID WHIRL AND FLUID WHIP MODES

AGNES MUSZYNSKA *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 277-291 Jan. 1994

Avail: CASI HC A03/MF A04

Fluid whirl and fluid whip are rotor self-excited, lateral vibrations which occur due to rotor interactions with the surrounding fluid. There exist various modes of fluid whirl and fluid whip. These modes are close to rotor modes corresponding to free vibrations (based on the linear model). Small differences are due to nonlinearities in the system. This paper presents experimental and analytical results on the lowest modes of fluid whirling and fluid whip. Examples of rotors supported in fluid lubricated bearings show the variations of rotor deflection amplitudes and phases in the whirl and whip modes with changes of rotative speeds and/or changes in lumped mass locations along the shaft. Author

N94-34192* Mechanical Technology, Inc., Latham, NY.

AN INVESTIGATION OF ANGULAR STIFFNESS AND DAMPING COEFFICIENTS OF AN AXIAL SPLINE COUPLING IN HIGH-SPEED ROTATING MACHINERY

C.-P. ROGER KU, JAMES F. WALTON, JR., and JORGEN W. LUND *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 293-303 Jan. 1994 Sponsored by NASA. Marshall Space Flight Center Avail: CASI HC A03/MF A04

This paper provided an opportunity to quantify the angular stiffness and equivalent viscous damping coefficients of an axial spline coupling used in high-speed turbomachinery. A unique test methodology and data reduction procedures were developed. The bending moments and angular deflections transmitted across an axial spline coupling were measured while a nonrotating shaft was excited by an external shaker. A rotor dynamics computer program was used to simulate the test conditions and to correlate the angular stiffness and damping coefficients. In addition, sensitivity analyses were performed to show that the accuracy of the dynamic coefficients do not rely on the accuracy of the data reduction procedures. Author (revised)

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STABILITY AND STABILITY DEGREE OF A CRACKED FLEXIBLE ROTOR SUPPORTED ON JOURNAL BEARINGS

GUANG MENG and ROBERT GASCH *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 305-323 Jan. 1994 Sponsored by Alexander von Humboldt Foundation and Huo Ying-Dong Youth Teachers Foundation

Avail: CASI HC A03/MF A04

This paper investigates the stability and the stability degree of a flexible cracked rotor supported on different kinds of journal bearings. It is found that no matter what kind of bearings is used, the unstable zones caused by rotor crack locate always within the speed ratio $(2/N)$ ($1 - \Delta K(\text{sub } \xi)/4$) is less than Ω is less than $2/N$ when gravity parameter $W(\text{sub } R)$ is greater than 1.0, and locate

always within the speed ratio $(2 \Omega(\text{sub } \alpha)/N)$ ($1 - \Delta K(\text{sub } \xi)/4$) is less than Ω is less than $2 \Omega(\text{sub } \alpha)/N$ when $W(\text{sub } R)$ is less than 0.1, where $\Delta K(\text{sub } \xi)$ is the crack stiffness ratio, $N = 1, 2, 3, 4, 5, \dots$, and $\Omega(\text{sub } \alpha) = ((1 + 2 \alpha)/2 \alpha)(\exp 1/2)$. When 0.1 is less than $W(\text{sub } R)$ is less than 1.0, there is a region where no unstable zones caused by rotor crack exist. Outside the crack ridge zones, the rotor crack has almost no influence on system's stability and stability degree; while within the crack ridge zones, the stability and stability degree depend both on the crack and system's parameters. In some cases, the system may still be stable even when the crack is very large. For small gravity parameter ($W(\text{sub } R)$ is less than 0.1), the mass ratio α has large influence on the position of unstable region, but its influence on the stability degree is small. The influence of fixed Sommerfeld number $S(\text{sub } 0)$ on the crack stability degree is small although $S(\text{sub } 0)$ has large influence on the stability degree of uncracked rotor.

Author (revised)

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AN EXPERIMENTAL AND THEORETICAL STUDY OF STRUCTURAL DAMPING IN COMPLIANT FOIL BEARINGS

C.-P. ROGER KU *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 327-337 Jan. 1994

Avail: CASI HC A03/MF A04

This paper describes an experimental investigation into the dynamic characteristics of corrugated foil (bump foil) strips used in compliant surface foil bearings. This study provided an opportunity to quantify the structural damping of bump foil strips. The experimental data were compared to results obtained by a theoretical model developed earlier. The effects of bearing design parameters, such as static loads, dynamic displacement amplitudes, bump configurations, pivot locations, surface coatings, and lubricant were also evaluated. An understanding of the dynamic characteristics of bump foil strips resulting from this work offers designers a means for enhancing the design of high-performance compliant foil bearings. Author (revised)

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PARAMETER IDENTIFICATION OF A ROTOR SUPPORTED IN A PRESSURIZED BEARING LUBRICATED WITH WATER

JOHN W. GRANT, AGNES MUSZYNSKA, and DONALD E. BENTLY *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1993 p 373-384 Jan. 1994

Avail: CASI HC A03/MF A04

A rig for testing an externally pressurized (hydrostatic), water-lubricated bearing was developed. Applying a nonsynchronous sweep frequency, rotating perturbation force with a constant amplitude as an input, rotor vibration response data was acquired in Bode and Dynamic Stiffness formats. Using this data, the parameters of the rotor/bearing system were identified. The rotor/bearing model was represented by the generalized (modal) parameters of the first lateral mode, with the rotational character of the fluid force taken into account. Author

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INFLUENCE OF AN ASYMMETRIC RING ON THE MODELING OF AN ORTHOGONALLY STIFFENED CYLINDRICAL SHELL

NAVEEN RASTOGI and ERIC R. JOHNSON 1994 45 p

(Contract NAG1-537)

(NASA-CR-195953; NAS 1.26:195953) Avail: CASI HC A03/MF A01

Structural models are examined for the influence of a ring with an asymmetrical cross section on the linear elastic response of an orthogonally stiffened cylindrical shell subjected to internal pressure. The first structural model employs classical theory for the shell and stiffeners. The second model employs transverse shear deformation theories for the shell and stringer and classical theory for the

ring. Closed-end pressure vessel effects are included. Interacting line load intensities are computed in the stiffener-to-skin joints for an example problem having the dimensions of the fuselage of a large transport aircraft. Classical structural theory is found to exaggerate the asymmetric response compared to the transverse shear deformation theory.

Author

N94-34300* North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.

SEMI-SPAN MODEL TESTING IN THE NATIONAL TRANSONIC FACILITY Semiannual Status Report

NDAONA CHOKANI May 1994 21 p

(Contract NCC1-169)

(NASA-CR-195952; NAS 1.26:195952) Avail: CASI HC A03/MF A01

The present work was motivated by an ongoing research program at NASA Langley Research Center to develop a semi-span testing capability for the National Transonic Facility (NTF). This test technique is being investigated as a means to design and optimize high-lift devices at flight Reynolds numbers in a ground test facility. Even though the freestream Mach numbers of interest are around .20, the flow around a transport wing with high lift devices deployed may contain regions of compressible flow. Thus to properly model the flow physics, a compressible flow solver may be required. However, the application of a compressible flow solver at low Mach numbers can be problematic. The objective of this phase of the project is to directly compare the performance of two widely used three-dimensional compressible Navier-Stokes solvers at low Mach numbers to both experimental data and to results obtained from an incompressible Navier-Stokes solver. The geometries of interest are two isolated wings with different leading edge sweep angles. The compressible Navier-Stokes solvers chosen, TLNS3D-MB and CFL3D, which were developed at NASA Langley Research Center (LaRC), represent the current state-of-the-art in compressible 3-D Navier-Stokes solvers. The incompressible Navier-Stokes solver, INS3D-UP, developed recently at NASA Ames Research Center (ARC), represents the current state-of-the-art in incompressible Navier-Stokes solvers.

Derived from text

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INTEGRATED CONTROL AND MANAGEMENT OF ADVANCED AIRCRAFT ELECTRICAL POWER SYSTEM

YOU-REN WANG, YANG-GUANG YAN, and SHI-HONG LU *In* Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 110-114 1993

Avail: CASI HC A01/MF A03

This paper studies the integrated control and management technology in airplane electrical power systems. The architectures of Advanced Aircraft Electrical Power System with Integrated Control and Management (AAEPSICM) are discussed. The concept of hierarchical distributed computer control which is applied in AAEPSICM is developed. The designs of system application software are considered. Functions and characteristics of the AAEPSICM's primary parts are analyzed in detail.

Author

N94-34368* Anhui Inst. of Optics and Fine Mechanics, Hefei (China).

COMPUTER ASSISTANT TEST AND CONSULTIVE SYSTEM FOR AIRCRAFT FLUID ELEMENT

JIN-RU LIU *In* Nanjing Aeronautical Inst., Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 268-270 1993

Avail: CASI HC A01/MF A03

The fluid bearing elements of an aircraft's control system are discussed in the context of aviation maintenance engineering. This paper explores the development of an artificially intelligent assistant to aid in the maintenance of hydraulic control systems.

Author (revised)

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FLOW FIELD ANALYSIS IN A HIGH PRESSURE RATIO CENTRIFUGAL COMPRESSOR

H. PAK, H. KRAIN, and B. HOFFMANN *In* AGARD, Technology Requirements for Small Gas Turbines 12 p Mar. 1994

Copyright Avail: CASI HC A03/MF A04

Detailed experimental and theoretical flow field studies were carried out for a high pressure ratio impeller with a high flow coefficient associated with transonic inlet flow. Experimental data were obtained by using the Laser-Two-Focus velocimetry. A 3D viscous code was applied to calculate the flow field. Comparisons between measured and calculated data are presented for 10 cross flow planes with special attention given to the impeller inlet, which is where the transonic flow occurs.

Author (revised)

N94-34450* BMW Rolls-Royce AeroEngines G.m.b.H., Lohhof (Germany).

AERODYNAMIC DESIGN AND INVESTIGATION OF A MIXED FLOW COMPRESSOR STAGE

GERNOT EISENLOHR and FRIEDRICH WILHELM BENFER *In* AGARD, Technology Requirements for Small Gas Turbines 8 p Mar. 1994 Sponsored by BMFT

Copyright Avail: CASI HC A02/MF A04

Topic of this contribution is a single stage mixed flow compressor with 6:1 pressure ratio, which is under development as a component for a turbojet. Primary design aim for the stage was to achieve minimum frontal area at a high efficiency level. Excerpts of the considerations and calculations for determining the design rotational speed and the main dimensions of this mixed flow compressor stage are presented first. Some explanations concerning the definition of the meridional contours and the generation of the blading are given, supplemented by several results of the impeller flow calculations. After a brief description of the test rig and its instrumentation, the measured impeller characteristics are presented. They show that the impeller meets its design pressure ratio and exceeds the efficiency target. For selected operating points the measured pressure distributions along the impeller outer contour are compared with the predicted static pressure rise. The discussions of the test results closes with the measured mixed flow compressor map which reveals that the overall stage performance does not fully meet the design goals, mainly because of high losses in the diffusing system.

Author (revised)

N94-34451* Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany). Inst. fuer Antriebstechnik.

DESIGN AND ANALYSIS OF A HIGHLY LOADED TRANSONIC COMPRESSOR CASCADE

E. NICKE, W. STEINERT, A. WEBER, and H. STARKEN *In* AGARD, Technology Requirements for Small Gas Turbines 14 p Mar. 1994

Copyright Avail: CASI HC A03/MF A04

Starting from two existing cascades a new one was developed for the same inlet and exit flow conditions but increased pitch to chord ratio: inlet Mach number $M(\text{sub } 1) = 1.09$, flow turning $\Theta = 14$ degrees, and pitch to chord ratio $s/c = 0.8$. Perspective research goal is the determination of the loading limits of transonic compressor cascades. The design was performed in the direct mode using a two dimensional Euler code coupled iteratively with an integral boundary layer code generating a profile Mach number distribution that avoids boundary layer separation. The experiments in a transonic cascade wind tunnel revealed performance, profile, Mach number distribution, and wake traverse data. A laser, two focus measurement technique was used to analyze the flow field upstream of the cascade and around the leading edge. The experimental results are analyzed by the Euler code. To improve the reliability of experimental as well as numerical inlet flow angle determination, the influence of conventional inlet boundary conditions versus so called nonreflecting boundary conditions was tested and verified using the L2F results.

Author (revised)

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NUMERICAL SIMULATION OF AIRFOIL FILM COOLING: A JET IN CROSSFLOW

H. J. SAABAS and A. RIAHI *In* AGARD, Technology Requirements for Small Gas Turbines 13 p Mar. 1994
Copyright Avail: CASI HC A03/MF A04

A control volume finite difference method based on the work of Rhie in conjunction with a two layer turbulence model has been used to predict mean velocities, turbulent kinetic energy, and film effectiveness profiles downstream of a single round jet normal to cross stream at a mass flux ratio of unity. Computations were obtained for domain discretizations in which (1) the jet velocity, and turbulent kinetic energy profiles were specified at the inlet to the cross flow, and (2) the jet delivery tube and the cross flow were solved for simultaneously using a multiblock approach. The multiblock solutions were carried out for both a circular and rectangular representation of the jet. The numerical results are compared to experimental measurements available in the open literature. The comparisons indicate that the modeling of the hole as circular or rectangular had only a small influence on the predicted flow field and film effectiveness downstream of the hole. However, when jet inlet profiles are specified (rather than calculated), the resulting flow field predictions show deviations from the multiblock solutions especially in the near hole region. This leads to poor agreement between predicted and observed film effectiveness distributions. Author

N94-34463# Turbomeca S.A. - Brevets Szydlowski, Bordes (France).

VIBRATIONS OF STRUCTURES WITH CYCLIC SYMMETRY: APPLICATION TO THE CASE OF TURBINE ENGINES [VIBRATIONS DE STRUCTURES A SYMETRIE CYCLIQUE: APPLICATION AU CAS DES TURBOMACHINES]

LUDOVIC MEZIERE *In* AGARD, Technology Requirements for Small Gas Turbines 9 p Mar. 1994 *In* FRENCH
Copyright Avail: CASI HC A02/MF A04

A great number of gas turbine components gives cyclic symmetry properties which may be useful to analyze such parts. The resonance occurrences are numerous because of the different harmonics of the rotational speed. Shift phase characteristics between each periodic sector can be easily used to represent the complex system forces made of air flow distortions for instance. The aerodynamical forces are transmitted to the structure mainly by the blades. From this point, we note under some stationary pressure deviations, fixed in the space reference, that the airfoil undergoes pressure fluctuations during its revolution cycle. This stationary phenomena is periodic in the blade reference. It shows a forward or backward wave propagation whose frequency is determined within each frame. A couple of eigen modes, except under some particular conditions, can be found using cyclic symmetry conditions at exactly the same eigen value. The linear combination of both modes are used to analyze the wave propagation. Resonance conditions are shown in this paper and an assessment of an excitability factor has been introduced to reckon the potentially dangerous modes. This method is applied on a modal analysis of an impeller of a gas turbine engine designed by TURBOMECA. This step is pre-requisite to a complete simulation of dynamic responses incorporating dissipative functions and the aeroelastic coupling which mainly governs such a vibration phenomena. Author

N94-34464# Pratt and Whitney Aircraft of Canada Ltd., Longueuil (Quebec). Static Structure Dept.

ENGINE STATIC STRUCTURES BEHAVIOUR UNDER IMPACT LOAD USING 3D MODELLING

T. LUCAS and K. S. VAN *In* AGARD, Technology Requirements for Small Gas Turbines 22 p Mar. 1994 Original contains color illustrations
Copyright Avail: CASI HC A03/MF A04

The 3-D finite element method is used to simulate the structural effects of turbine blade impact on gas turbine engine structural

casings and flanges, including both local effects and load transfer to the mounts. The analysis uses United Technologies' code WHAM to determine dynamic impact loads, and commercial codes MARC or MSC/NASTRAN to obtain transient stresses and distortions in the casings. The analysis is compared qualitatively and quantitatively to engine test results. Good correlation is obtained in predicting the observed failure. Author

N94-34466# Sussex Univ., Brighton (England). Thermo-Fluid Mechanics Research Centre.

AN AIR BEARING SYSTEM FOR SMALL HIGH SPEED GAS TURBINES

A. B. TURNER, S. J. DAVIES, and Y. L. NIMIR *In* AGARD, Technology Requirements for Small Gas Turbines 8 p Mar. 1994 Sponsored by Rolls-Royce Ltd. and Aisin Seiki Co. Ltd.
Copyright Avail: CASI HC A02/MF A04

This paper describes the second phase of an experimental program concerning the application of air bearings to small turbomachinery test rigs and small gas turbines. The first phase examined externally pressurized (EP) journal bearings, with a novel EP thrust bearing, for application to 'warm air' test rigs, and was entirely successful at rotational speeds in excess of 100,000 rpm. This second phase examined several designs of tilting pad-spring journal bearings, one with a novel form of externally pressurized pad, but all using the original EP thrust bearing. The designs tested are described, including some oscillogram traces, for tests up to a maximum of 70,000 rpm; the most successful using a carbon pad-titanium beam spring arrangement. The thrust bearing which gave trouble-free operation throughout, is also described. The results of an original experiment to measure the 'runway speed' of a radial inflow turbine are also presented, which show that overspeeds of 58 percent above the design speed can result from free-power turbine coupling failure. Author

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

N94-33170# Denver Univ., CO. Dept. of Engineering.
COUNTING PARTICLES EMITTED BY STRATOSPHERIC AIRCRAFT AND MEASURING SIZE OF PARTICLES EMITTED BY STRATOSPHERIC AIRCRAFT Final Technical Report, 1 May 1990 - 31 Dec. 1992
JAMES CHARLES WILSON 19 Apr. 1994 28 p
(Contract NCC2-666)
(NASA-CR-195908; NAS 1.26:195908) Avail: CASI HC A03/MF A01

The ER-2 condensation nuclei counter (CNC) has been modified to reduce the diffusive losses of particles within the instrument. These changes have been successful in improving the counting efficiency of small particles at low pressures. Two techniques for measuring the size distributions of particles with diameters less than 0.17 micrometers have been evaluated. Both of these methods, the differential mobility analyzer (DMA) and the diffusion battery, have fundamental problems that limit their usefulness for stratospheric applications. We cannot recommend either for this application. Newly developed, alternative methods for measuring small particles include inertial separation with a low-loss critical orifice and thin-plate impactor device. This technique is now used to collect particles in the multisample aerosol collector housed in the ER-2 CNC-2, and shows some promise for particle size measurements when coupled with a CNC as a counting device. The modified focused-cavity aerosol spectrometer (FCAS) can determine the size distribution of particles with ambient diameters as small as about 0.07 micrometers. Data from this instrument indicates the presence of a nuclei

mode when CNC-2 indicates high concentrations of particles, but cannot resolve important parameters of the distribution.

Derived from text

N94-33457* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STRATOSPHERIC MODELS AND MEASUREMENTS: A CRITICAL COMPARISON

ELLIS E. REMSBERG *In its First Annual High-Speed Research Workshop, Part 1 p 461-463 Apr. 1992*

Avail: CASI HC A01/MF A04

The stated objectives of the High Speed Research Program/Atmospheric Effects of Stratospheric Aircraft (AESA) initiative are to support research in the atmospheric sciences that will improve the basic understanding of the circulation and chemistry of the stratosphere and lead to interim assessments of the impact of a projected fleet of HSCT's on the stratosphere. Three model comparison workshops have been conducted, so far, in support of this goal. These workshops have been focused on the differences between models used to calculate the atmospheric effects of the proposed aircraft emissions. It is now possible to test these models against atmospheric data.

Derived from text

N94-33460* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPARISON OF THE IMPACT OF VOLCANIC ERUPTIONS AND AIRCRAFT EMISSIONS ON THE AEROSOL MASS LOADING AND SULFUR BUDGET IN THE STRATOSPHERE

GLENN K. YUE and LAMONT R. POOLE *In its First Annual High-Speed Research Workshop, Part 1 p 481-495 Apr. 1992*

Avail: CASI HC A03/MF A04

Data obtained by the Stratospheric Aerosol and Gas Experiment (SAGE) 1 and 2 were used to study the temporal variation of aerosol optical properties and to assess the mass loading of stratospheric aerosols from the eruption of volcanos Ruiz and Kelut. It was found that the yearly global average of optical depth at 1.0 micron for stratospheric background aerosols in 1979 was $1.16 \times 10(\exp -3)$ and in 1989 was $1.66 \times 10(\exp -3)$. The eruptions of volcanos Ruiz and Kelut ejected at least $5.6 \times 10(\exp 5)$ and $1.8 \times 10(\exp 5)$ tons of materials into the stratosphere, respectively. The amount of sulfur emitted per year from the projected subsonic and supersonic fleet is comparable to that contained in the background aerosol particles in midlatitudes from 35 deg N to 55 deg N.

Author (revised)

N94-33461* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HIGH RESOLUTION INFRARED DATASETS USEFUL FOR VALIDATING STRATOSPHERIC MODELS

CURTIS P. RINSLAND *In its First Annual High-Speed Research Workshop, Part 1 p 499-504 Apr. 1992*

Avail: CASI HC A02/MF A04

An important objective of the High Speed Research Program (HSRP) is to support research in the atmospheric sciences that will improve the basic understanding of the circulation and chemistry of the stratosphere and lead to an interim assessment of the impact of a projected fleet of High Speed Civil Transports (HSCT's) on the stratosphere. As part of this work, critical comparisons between models and existing high quality measurements are planned. These comparisons will be used to test the reliability of current atmospheric chemistry models. Two suitable sets of high resolution infrared measurements are discussed.

Derived from text

N94-33938* Westinghouse Savannah River Co., Aiken, SC.

AERIAL ROBOTIC DATA ACQUISITION SYSTEM

K. J. HOFSTETTER, D. W. HAYES, M. M. PENDERGAST, and J. E. CORBAN 1993 6 p Presented at the International Conference on Methods and Applications of Radioanalytical Chemistry, Kona,

HI, 10-16 Apr. 1994

(Contract DE-AC09-89SR-18035)

(DE94-009114; WSRC-MS-93-453; CONF-940401-2) Avail: CASI HC A02/MF A01

A small, unmanned aerial vehicle (UAV), equipped with sensors for physical and chemical measurements of remote environments, is described. A miniature helicopter airframe is used as a platform for sensor testing and development. The sensor output is integrated with the flight control system for real-time, interactive, data acquisition and analysis. Preprogrammed flight missions will be flown with several sensors to demonstrate the cost-effective surveillance capabilities of this new technology.

DOE

N94-34115* Technische Univ., Delft (Netherlands). Faculteit der Geodesie.

ERROR ANALYSIS OF THE STEP DRAG-FREE SYSTEM WITH RESPECT TO GRAVITY FIELD DETERMINATION

J. C. KESTER Aug. 1993 80 p

(PB94-149804) Avail: CASI HC A05/MF A01

In the satellite geodesy the gravity potential of the earth is determined from orbit analysis. For this purpose the potential is written as Fourier series along the orbit, periodicity is obtained once the satellite in its orbit and the orbit relative to an earth-fixed frame both have made an integer number of revolutions. The partial derivatives of the gravity potential are coupled with displacements in the satellite's position by means of the Hill equations. The displacements are measured with global positioning system (GPS) positioning. A model can be derived that couples the GPS measurements with the potential coefficients. The satellite is also subject to non-conservative forces, like air-drag. The non-conservative forces are deterministic noise for the (satellite geodesy) model that determines potential coefficients from GPS position measurements. A drag-free system aboard of the STEP satellite measures these disturbances and produces a contraforce by means of helium thrusters. By so doing, most of the drag is cancelled, but the system is not perfect, there remains a residual acceleration. The spectrum of this drag-free noise is continuous. The error spectrum of the potential coefficients is computed from the total of the GPS measurement noise and the drag-free noise and is presented in the thesis.

NTIS

N94-34382* Sandia National Labs., Albuquerque, NM.

A SAR IMAGE-FORMATION ALGORITHM THAT COMPENSATES FOR THE SPATIALLY-VARIANT EFFECTS OF ANTENNA MOTION

B. L. BURNS and J. T. CORDARO 1994 12 p Presented at the Society of Photo-Optical Instrumentation Engineers Conference on Intelligent Information Systems, Orlando, FL, 4-8 Apr. 1994

(Contract DE-AC04-94AL-85000)

(DE94-008456; SAND-93-2125C; CONF-940449-5) Avail: CASI HC A03/MF A01

A synthetic aperture radar (SAR) obtains azimuth resolution by combining data from a number of points along a specified path. Uncompensated antenna motion that deviates significantly from the desired path produces spatially-variant errors in the output image. The algorithm presented in this paper corrects many of these motion-related errors. In this respect, it is similar to time-domain convolution, but it is more computationally efficient. The algorithm uses overlapped subapertures in a three-step image-formation process: coarse-resolution azimuth processing, fine-resolution range processing, and fine-resolution azimuth processing. Range migration is corrected after the first stage, based on coarse azimuth position. Prior to the final azimuth-compression step, data coordinates, are determined to fine resolution in range and coarse resolution in azimuth. This coordinate information is combined with measured motion data to generate a phase correction that removes spatially-variant errors. The algorithm is well-suited for real-time applications, particularly where large flight-path deviations must be tolerated.

DOE

15 MATHEMATICAL AND COMPUTER SCIENCES

N94-34408# National Weather Service, Fort Worth, TX. IMPACT OF WEATHER ON FLIGHT OPERATIONS AT A MAJOR AIRPORT

J. R. OTT and J. W. LADD Mar. 1994 18 p See also NTISUB-D-104003
(PB94-127990; NOAA-TM-NWS-SR-154) Avail: CASI HC A03/MF A01

Following the crash of a Southern Airways jet at New Hope, Georgia, on April 4, 1977, the Federal Aviation Administration (FAA) recognized the need of timely dissemination of hazardous weather conditions to flight crews (National Transportation Safety Board, 1977). The establishment of the Center Weather Service Unit (CWSU) in each of the Air Route Traffic Control Centers (ARTCC) resulted. The Dallas/Fort Worth International Airport (DFW) is a major complex — rated the second busiest in the world behind Chicago O'Hare International Airport (ORD). The paper will examine the impact that adverse weather conditions, especially those that may not be accurately forecast, can have on DFW operations. Emphasis will be placed on the importance of coordination between the CWSU and ARTCC personnel, and also between the CWSU and the Weather Service Forecast Office (WSFO). NTIS

N94-34409 Research Triangle Inst., Research Triangle Park, NC. TOXIC EMISSIONS FROM AIRCRAFT FIREFIGHTING TRAINING: A SEARCH OF AVAILABLE LITERATURE

Jul. 1993 63 p Sponsored by EPA Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (PB94-156783; EPA/453/R-93/027) Avail: CASI HC A04

The document attempts to compile citations and brief descriptions of studies and data regarding toxic air emissions released during training exercises for firefighting at airports. Many training exercises use real aviation fuels (JP4, JP5...) to simulate real fire conditions. The burning of such fuels also causes the release of toxic combustion by-products. Such practices have raised concerns about the public health effects of the combustion by-products. Little is known about the emission characteristics of such burning. The purpose of the work is to find what recent data are available on the toxic and volatile organic compound (VOC) emissions and on health effects from open burning of aviation fuels. NTIS

15

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

N94-32423*# Naval Air Warfare Center, Lakehurst, NJ. Aircraft Div.

FUZZY-NEURAL CONTROL OF AN AIRCRAFT TRACKING CAMERA PLATFORM

DENNIS MCGRATH In NASA, Washington, Technology 2003: The Fourth National Technology Transfer Conference and Exposition, Volume 2 p 17-23 Feb. 1994
Avail: CASI HC A02/MF A04

A fuzzy-neural control system simulation was developed for the control of a camera platform used to observe aircraft on final approach to an aircraft carrier. The fuzzy-neural approach to control combines the structure of a fuzzy knowledge base with a supervised neural network's ability to adapt and improve. The performance characteristics of this hybrid system were compared to those of a fuzzy system and a neural network system developed independently to determine if the fusion of these two technologies offers any advantage over the use of one or the other. The results of this study indicate that the fuzzy-neural approach to control offers some advantages over either fuzzy or neural control alone. Author

N94-32430*# PDA Engineering, Santa Ana, CA. ANALYTICAL DESIGN PACKAGE (ADP2): A COMPUTER AIDED ENGINEERING TOOL FOR AIRCRAFT TRANSPARENCY DESIGN

J. E. WUERER, M. GRAN, and T. W. HELD In NASA, Washington, Technology 2003: The Fourth National Technology Transfer Conference and Exposition, Volume 2 p 80-92 Feb. 1994
Avail: CASI HC A03/MF A04

The Analytical Design Package (ADP2) is being developed as a part of the Air Force Frameless Transparency Program (FTP). ADP2 is an integrated design tool consisting of existing analysis codes and Computer Aided Engineering (CAE) software. The objective of the ADP2 is to develop and confirm an integrated design methodology for frameless transparencies, related aircraft interfaces, and their corresponding tooling. The application of this methodology will generate high confidence for achieving a qualified part prior to mold fabrication. ADP2 is a customized integration of analysis codes, CAE software, and material databases. The primary CAE integration tool for the ADP2 is P3/PATRAN, a commercial-off-the-shelf (COTS) software tool. The open architecture of P3/PATRAN allows customized installations with different applications modules for specific site requirements. Integration of material databases allows the engineer to select a material, and those material properties are automatically called into the relevant analysis code. The ADP2 materials database will be composed of four independent schemas: CAE Design, Processing, Testing, and Logistics Support. The design of ADP2 places major emphasis on the seamless integration of CAE and analysis modules with a single intuitive graphical interface. This tool is being designed to serve and be used by an entire project team, i.e., analysts, designers, materials experts, and managers. The final version of the software will be delivered to the Air Force in Jan. 1994. The Analytical Design Package (ADP2) will then be ready for transfer to industry. The package will be capable of a wide range of design and manufacturing applications. Author (revised)

N94-33286*# Institute for Computer Applications in Science and Engineering, Hampton, VA.

CUMULATIVE REPORTS AND PUBLICATIONS THROUGH DECEMBER 31, 1993 Final Report

Mar. 1994 100 p
(Contract NAS1-19480; RTOP 505-90-52-01)
(NASA-CR-194889; NAS 1.26:194889) Avail: CASI HC A05/MF A02

This document contains a complete list of ICASE reports. Since ICASE reports are intended to be preprints of articles that will appear in journals or conference proceedings, the published reference is included when it is available. Author

N94-33335 Royal Military Coll. of Canada, Kingston (Ontario). PROCEEDINGS OF THE SYMPOSIUM/WORKSHOP ON APPLICATIONS OF EXPERT SYSTEMS IN DND

GEORGES AKHRAS, ed. and PIERRE ROBERGE, ed. Apr. 1992 241 p Symposium/Workshop held in Kingston, Ontario, 23-24 Apr. 1992
(DSIS-93-00343; CTN-94-61182) Avail: Issuing Activity (Royal Military Coll. of Canada, Vimy Post Office, Kingston, ON K7K 5L0 Canada)

A symposium was organized with the intent of creating a vehicle, within the Canadian Department of National Defence, to promote, stimulate, and demystify the development of expert systems and their applications to engineering. Papers were presented on expert systems for applications such as electronic warfare, mission scheduling, threat evaluation, aircraft and avionics maintenance, digital circuit diagnostics, particle accelerator control, air traffic control, search and rescue tracking, and building inspection. More general topics such as knowledge acquisition and expert system development were also included. Separate abstracts have been prepared for 11 papers from this symposium. Author (CISTI)

N94-33744 Illinois Univ., Champaign, IL.
REAL-TIME ADAPTIVE CONTROL OF MIXING IN A PLANE SHEAR LAYER Final Report, 15 Jan. 1990 - 14 Jul. 1993
 ARNE J. PEARLSTEIN 2 Feb. 1994 66 p Limited Reproducibility:
 More than 20% of this document may be affected by microfiche quality
 (Contract AF-AFOSR-0156-90)
 (AD-A278379; AFOSR-94-0163TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Work was conducted on two projects related to real-time control of shear flows. In the first, two dimensional unsteady simulations of the development of the wake behind a circular cylinder impulsively started into rotatory and rectilinear motion were performed. This simulation code is now serving as a testbed for the development of open and closed-loop strategies for control of the lift/drag ratio as well as the suppression of vortex shedding. The code has been checked by comparison to earlier computational and experimental work. In the second project, a technique was developed to extract both velocity components in a two dimensional incompressible flow from measurements of a single scalar (temperature or concentration), and all three velocity components in a three dimensional incompressible flow from measurements of two scalars. The technique is applicable to steady or unsteady, laminar or turbulent flows. A key advantage over particle image velocimetry and other multipoint techniques is that our method uses full-field optical measurements, so that spatial resolution is not limited by particle size and loading restrictions. DTIC

N94-34125 Newcastle-upon-Tyne Univ. (England). Dept. of Computing Science.
BUILDING FAULT-TOLERANT DISTRIBUTED COMPUTING SYSTEMS USING STANDARD COMPONENTS
 P. A. BARRETT, S. K. SHRIVASTAVA, N. A. SPEIRS, and A. WATERWORTH 1993 15 p
 (PB94-148889; TRS-449) Copyright Avail: Issuing Activity (National Technical Information Service (NTIS))

The paper investigates the possibility of constructing fault-tolerant computer systems using standard hardware components, replicated to an appropriate degree and communicating via special-purpose software protocols. The Voltan family of fail-controlled nodes is introduced and described, and ways of incorporating Voltan nodes into Integrated Modular Avionics (IMA) architectures are presented. Means of overcoming the potential drawbacks of such nodes are discussed. In particular, possible extensions to IMA gateway modules in order to provide communications and data validation services in support of Voltan nodes are described.

NTIS

N94-34308# Nanjing Aeronautical Inst. (China).
PROCEEDINGS OF THE ASIA-PACIFIC CONFERENCE ON CONTROL AND MEASUREMENT (APCCM 1993), VOLUME 10, NO. 1
 1993 306 p Conference held in Kunming, China, 5-7 Dec. 1993
 Sponsored by Jiangsu Society of Aeronautics and Astronautics and IEEE
 (ISSN 1005-1120)
 Avail: CASI HC A14/MF A03

These conference proceedings have 65 papers. The scope of the papers consists of: automatic control theory and applications, adaptive control, robust control, robotic control, intelligent control, variable structure control, optimal control, neural network control, distributed control, process control, fault diagnostics and detection, intelligent sensors, fiber optical sensors, digital image measurement, microcomputer and measurement technology. The papers are divided as follows: control theory and applications, flight control, control on industry and engineering and others, and measurement

and test. It is believed the conference will have rendered international communication and scientific and technological exchanges for promotion of control and measurement science.

N94-34370# Nanjing Aeronautical Inst. (China). Dept. of Automatic Control Engineering.
NOMINAL H(EXP 2)-OPTIMIZATION AND STRONG STABILIZATION: A PRACTICAL EXAMPLE OF U-PARAMETERIZATION DESIGN
 YANG WEI and CHUN-LIN SHEN In its Proceedings of the Asia-Pacific Conference on Control and Measurement (APCCM 1993), Volume 10, No. 1 p 276-280 1993
 Avail: CASI HC A01/MF A03

This paper is concerned with the problem of finding a controller for a feedback control system which minimizes an $H(\text{sub } 2)$ -norm of a weighted sensitivity function. The solution to this problem consists of two steps: (1) showing that the Youla strong stabilization (stabilization with stable controllers) approach, using sensitivity functions, can lead to a unit interpolation problem; and (2) using a free strongly bounded real function, the U-parameter in this case, to study the problem of designing an $H(\text{sub } 2)$ -optimal stable controller for a scalar system. Additionally, we propose that the free parameter be applied to a practical flight control system design for wind-shear protection, where data is used from the Eastern airlines flight 66 which crashed at J. F. Kennedy International airport. It is shown that the resultant flight control system can make an aircraft successfully land in no wind-shear (stable dynamics) and wind-shear (unstable dynamics) conditions. Author (revised)

16 PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

N94-32930*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A MATHEMATICAL MODEL FOR SIMULATING NOISE SUPPRESSION OF LINED EJECTORS
 WILLIE R. WATSON Apr. 1994 30 p
 (Contract RTOP 505-59-52-02)
 (NASA-TP-3425; L-17283; NAS 1.60:3425) Avail: CASI HC A03/MF A01

A mathematical model containing the essential features embodied in the noise suppression of lined ejectors is presented. Although some simplification of the physics is necessary to render the model mathematically tractable, the current model is the most versatile and technologically advanced at the current time. A system of linearized equations and the boundary conditions governing the sound field are derived starting from the equations of fluid dynamics. A nonreflecting boundary condition is developed. In view of the complex nature of the equations, a parametric study requires the use of numerical techniques and modern computers. A finite element algorithm that solves the differential equations coupled with the boundary condition is then introduced. The numerical method results in a matrix equation with several hundred thousand degrees of freedom that is solved efficiently on a supercomputer. The model is validated by comparing results either with exact solutions or with approximate solutions from other works. In each case, excellent correlations are obtained. The usefulness of the model as an optimization tool and the importance of variable impedance liners as a mechanism for achieving broadband suppression within a lined ejector are demonstrated. Author

N94-33023* BBN Systems and Technologies Corp., Cambridge, MA.

RECIPROCITY-BASED EXPERIMENTAL DETERMINATION OF DYNAMIC FORCES AND MOMENTS: A FEASIBILITY STUDY Final Report

ISTVAN L. VER and MICHAEL S. HOWE May 1994 72 p Prepared for Georgia Inst. of Tech., Atlanta, GA

(Contract NAS1-19061; BBN PROJ. 621697; RTOP 538-03-14-01) (NASA-CR-194905; NAS 1.26:194905; BBN-7967) Avail: CASI HC A04/MF A01

BBN Systems and Technologies has been tasked by the Georgia Tech Research Center to carry Task Assignment No. 7 for the NASA Langley Research Center to explore the feasibility of 'In-Situ Experimental Evaluation of the Source Strength of Complex Vibration Sources Utilizing Reciprocity.' The task was carried out under NASA Contract No. NAS1-19061. In flight it is not feasible to connect the vibration sources to their mounting points on the fuselage through force gauges to measure dynamic forces and moments directly. However, it is possible to measure the interior sound field or vibration response caused by these structureborne sound sources at many locations and invoke principle of reciprocity to predict the dynamic forces and moments. The work carried out in the framework of Task 7 was directed to explore the feasibility of reciprocity-based measurements of vibration forces and moments.

Author

N94-33464* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

HIGH SPEED JET NOISE RESEARCH AT NASA LEWIS

EUGENE A. KREJSA, B. A. COOPER, C. M. KIM, and ABBAS KHAVARAN In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 519-532 Apr. 1992

Avail: CASI HC A03/MF A04

The source noise portion of the High Speed Research Program at NASA LeRC is focused on jet noise reduction. A number of jet noise reduction concepts are being investigated. These include two concepts, the Pratt & Whitney ejector suppressor nozzle and the General Electric (GE) 2D-CD mixer ejector nozzle, that rely on ejectors to entrain significant amounts of ambient air to mix with the engine exhaust to reduce the final exhaust velocity. Another concept, the GE 'Flade Nozzle' uses fan bypass air at takeoff to reduce the mixed exhaust velocity and to create a fluid shield around a mixer suppressor. Additional concepts are being investigated at Georgia Tech Research Institute and at NASA LeRC. These will be discussed in more detail in later figures. Analytical methods for jet noise prediction are also being developed. Efforts in this area include upgrades to the GE MGB jet mixing noise prediction procedure, evaluation of shock noise prediction procedures, and efforts to predict jet noise directly from the unsteady Navier-Stokes equation.

Author

N94-33465* Pratt and Whitney Aircraft, East Hartford, CT. **HSCT NOZZLE SOURCE NOISE PROGRAMS AT PRATT AND WHITNEY**

ALFRED M. STERN In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 535-549 Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: 20 dB jet noise suppression; ejector nozzle technology program - noise reduction vs. flow augmentation; mixer ejector nozzle technology challenges; 1989 High Speed Civil Transport (HSCT) 2-D ejector model test in NASA's 9 x 15 ft. tunnel; tertiary airflow 1989 2-D ejector test; shock noise dominates 2-D ejector test; lessons learned - 2-D mixer/ejector in 9 x 15 ft. tunnel; 1990 HSCT axisymmetric ejector model test in Boeing's Low Speed Aeroacoustic Facility (LSAF); axisymmetric mixer/ejector mach contours - peak and valley - NASTAR pre-test predictions; tertiary airflow objectives accomplished - 1990 AXI model; and HSCT low noise exhaust technology programs.

Author

N94-33466* General Electric Co., Cincinnati, OH. Aircraft Engines.

HSCT NOISE REDUCTION TECHNOLOGY DEVELOPMENT AT GE AIRCRAFT ENGINES

RUDRAMUNI K. MAJJIGI In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 553-589 Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: High Speed Civil Transport (HSCT) exhaust nozzle design approaches; GE aircraft engine (GEAE) HSCT acoustics research; 2DCD non-IVP suppressor ejector; key sensitivities from reference aircraft; acoustic experiments; aero-mixing experimental set-up; fluid shield nozzle; HSCT Mach 2.4 flade nozzle; noise prediction; nozzle concept for GE/Boeing joint test; scale model hot core flow path modified to prevent hub-choking CFL3-D solution; HSCT exhaust nozzle status; and key acoustic technology issues for HSCT's.

Author

N94-33467* Boeing Commercial Airplane Co., Seattle, WA.

COMMUNITY NOISE SOURCES AND NOISE CONTROL ISSUES

GENE L. NIHART In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 593-606 Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: community noise sources and noise control issues; noise components for turbine bypass turbojet engine (TBE) turbojet; engine cycle selection and noise; nozzle development schedule; NACA nozzle design; NACA nozzle test results; nearly fully mixed (NFM) nozzle design; noise versus aspiration rate; peak noise test results; nozzle test in the Low Speed Aeroacoustic Facility (LSAF); and Schlieren pictures of NACA nozzle.

Author

N94-33469* Florida State Univ., Tallahassee, FL. Dept. of Mathematics.

THEORETICAL ASPECTS OF SUPERSONIC JET NOISE

CHRISTOPHER K. W. TAM In NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 647-662 Apr. 1992

Avail: CASI HC A03/MF A04

The topics covered include the following: the three components of supersonic jet noise; shock cell structure of imperfectly expanded jets; large turbulence structures/instability waves; supersonic jet noise theory; generation of turbulent mixing noise; comparisons between predicted peak noise frequency and direction of radiation with measurements; Strouhal number of maximum SPL of hot supersonic jets; near field sound pressure level contours; generation of broadband shock associated noise; calculated and measured far field shock noise spectra; generation of screech tones; and calculated and measured Strouhal number of screech tones.

Author

N94-33470* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DESIGN AND ANALYSIS OF LOW BOOM CONCEPTS AT LANGLEY RESEARCH CENTER

CHRISTINE M. DARDEN, ROBERT J. MACK, KATHY E. NEEDLEMAN, DANIEL G. BAIZE, PETER G. COEN, RAYMOND L. BARGER, N. DUANE MELSON, MARY S. ADAMS, ELWOOD W. SHIELDS, and MARVIN E. MCGRAW In its First Annual High-Speed Research Workshop, Part 2 p 675-699 Apr. 1992

Avail: CASI HC A03/MF A04

The objective of the sonic boom research in the current High Speed Research Program is to ultimately make possible overland supersonic flight by a high speed civil transport. To accomplish this objective, it is felt that results in four areas must demonstrate that such a vehicle would be acceptable by the general public, by the airframers, and by the airlines. It should be demonstrated: (1) that some waveform shape has the possibility of being acceptable to the general public; (2) that the atmosphere would not totally destroy such a waveform during propagation; (3) that a viable airplane could

be built which produces such a waveform; and (4) that any performance penalty suffered by a low boom aircraft would be counteracted by the economic benefit of overland supersonic flight. The work being done at LaRC is in support of the third element listed above—the area of configuration design. The initial part of the paper will give a review of the theory being used for configuration designs and discuss two theory validation models which were built and tested within the past two years. Discussion of the wind tunnel and theoretical results (linear theory and higher order methods) and their implications for future designs will be included. Author

N94-33472*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SONIC BOOM PREDICTION AND MINIMIZATION USING COMPUTATIONAL FLUID DYNAMICS

THOMAS A. EDWARDS, RAYMOND HICKS, SAMSON CHEUNG, SUSAN CLIFF-HOVEY, MIKE MADSON, and JOEL MENDOZA *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 723-738 Apr. 1992

Avail: CASI HC A03/MF A04

This paper describes the NASA ARC program in sonic boom prediction methodologies. This activity supports NASA's High Speed Research Program (HSRP). An overview of the program, recent results, conclusions, and current effort will be given. This effort complements research in sonic boom acceptability and validation being conducted at LaRC and ARC. The goals of the sonic boom element are as follows: to establish a predictive capability for sonic booms generated by High-Speed Civil Transport (HSCT) concepts; to establish guidelines of acceptability for supersonic overland flight; and to validate these findings with wind tunnel and flight tests. The cumulative result of these efforts will be an assessment of economic viability for supersonic transportation. This determination will ultimately be made by the aerospace industry. Author

N94-33474*# Grumman Aerospace Corp., Bethpage, NY.
SONIC BOOM PREDICTIONS USING A MODIFIED EULER CODE

MICHAEL J. SICLARI *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 759-784 Apr. 1992

Avail: CASI HC A03/MF A04

The environmental impact of a next generation fleet of high-speed civil transports (HSCT) is of great concern in the evaluation of the commercial development of such a transport. One of the potential environmental impacts of a high speed civilian transport is the sonic boom generated by the aircraft and its effects on the population, wildlife, and structures in the vicinity of its flight path. If an HSCT aircraft is restricted from flying overland routes due to excessive booms, the commercial feasibility of such a venture may be questionable. NASA has taken the lead in evaluating and resolving the issues surrounding the development of a high speed civilian transport through its High-Speed Research Program (HSRP). The present paper discusses the usage of a Computational Fluid Dynamics (CFD) nonlinear code in predicting the pressure signature and ultimately the sonic boom generated by a high speed civilian transport. NASA had designed, built, and wind tunnel tested two low boom configurations for flight at Mach 2 and Mach 3. Experimental data was taken at several distances from these models up to a body length from the axis of the aircraft. The near field experimental data serves as a test bed for computational fluid dynamic codes in evaluating their accuracy and reliability for predicting the behavior of future HSCT designs. Sonic boom prediction methodology exists which is based on modified linear theory. These methods can be used reliably if near field signatures are available at distances from the aircraft where nonlinear and three dimensional effects have diminished in importance. Up to the present time, the only reliable method to obtain this data was via the wind tunnel with costly model construction and testing. It is the intent of the present paper to apply a modified three dimensional Euler code to predict the near field signatures of the two low boom configurations recently tested by NASA. Author

N94-33475*# Eagle Engineering, Inc., Hampton, VA.

OVERVIEW OF FEASIBILITY STUDY ON CONDUCTING OVERFLIGHT MEASUREMENTS OF SHAPED SONIC BOOM SIGNATURES USING RPV'S

DOMENIC J. MAGLIERI, VICTOR E. SOTHCOTT, THOMAS N. KEEFER, JR., and PERCY J. BOBBITT *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 787-807 Apr. 1992

Avail: CASI HC A03/MF A04

Before beginning this presentation, it is appropriate to acknowledge the sincere interest and financial support provided by the NASA LaRC under contract NAS9-17900. An outline of the material to be used in the present paper is given. It begins with a indication of the origin and objectives of the feasibility study. This is followed by a discussion of various simulation methods of establishing the persistence of shaped sonic boom signatures to large distances including the use of recoverable RPV/drones. The desirable features to be sought out in an RPV along with a rationale for the selection of a 'shaped' sonic boom signature will be addressed. Three candidate vehicles are examined as to their suitability with respect to a number of factors, in particular, modifiability. Area distributions and associated sonic boom signatures of the basic and modified Firebee vehicle will also be shown. An indication of the scope of the proposed wind tunnel and flight test programs will be presented including measurement technologies and predicted waveforms. Finally, some remarks will be made summarizing the study and highlighting the key findings. Author

N94-33482*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THEORETICAL STUDY OF THERMODYNAMIC PROPERTIES AND REACTION RATES OF IMPORTANCE IN THE HIGH-SPEED RESEARCH PROGRAM

STEPHEN LANGHOFF, CHARLES BAUSCHLICHER, and RICHARD JAFFE *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 2 p 967-980 Apr. 1992

Avail: CASI HC A03/MF A04

One of the primary goals of NASA's high-speed research program is to determine the feasibility of designing an environmentally safe commercial supersonic transport airplane. The largest environmental concern is focused on the amount of ozone destroying nitrogen oxides (NO(x)) that would be injected into the lower stratosphere during the cruise portion of the flight. The limitations placed on NO(x) emission require more than an order of magnitude reduction over current engine designs. To develop strategies to meet this goal requires first gaining a fundamental understanding of the combustion chemistry. To accurately model the combustor requires a computational fluid dynamics approach that includes both turbulence and chemistry. Since many of the important chemical processes in this regime involve highly reactive radicals, an experimental determination of the required thermodynamic data and rate constants is often very difficult. Unlike experimental approaches, theoretical methods are as applicable to highly reactive species as stable ones. Also our approximation of treating the dynamics classically becomes more accurate with increasing temperature. In this article we review recent progress in generating thermodynamic properties and rate constants that are required to understand NO(x) formation in the combustion process. We also describe our one-dimensional modeling efforts to validate an NH₃ combustion reaction mechanism. We have been working in collaboration with researchers at LeRC, to ensure that our theoretical work is focused on the most important thermodynamic quantities and rate constants required in the chemical data base. Author

N94-33489*# Lockheed Aeronautical Systems Co., Marietta, GA.
NEW BROADBAND SHOCK NOISE MODEL AND COMPUTER CODE FOR ANOPP

N. N. REDDY *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1075-1101 Apr. 1992

Avail: CASI HC A03/MF A06

The basic mechanism for broadband shock noise in supersonic

jets is the interaction between the shock waves and the turbulence in the jet exhaust. This source is in addition to jet mixing noise.

Author (revised)

**N94-33490*# Boeing Commercial Airplane Co., Seattle, WA.
COMMUNITY NOISE TECHNOLOGY NEEDS: BOEING'S
PERSPECTIVE**

GENE L. NIHART *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1105-1119 Apr. 1992
Avail: CASI HC A03/MF A06

Airport community acceptance of High Speed Civil Transport (HSCT) noise levels will depend on the relative noise levels of airplanes flying at the time of introduction. The 85 dBA noise contours for the range of large subsonic airplanes that are expected to be in service in the early 21st century are shown as a shaded area. A certifiable HSCT noise contour as shown, would be somewhat wider along the runway, but about the same in the residential areas downrange. An HSCT noise rule should insure this noise capability.

Author

**N94-33491*# Douglas Aircraft Co., Inc., Long Beach, CA.
AERO ACOUSTIC ANALYSIS AND COMMUNITY NOISE. HSCT
CLIMB TO CRUISE NOISE ASSESSMENT**

ALAN K. MORTLOCK *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1123-1133 Apr. 1992

Avail: CASI HC A03/MF A06

The widely accepted industry High Speed Civil Transport (HSCT) design goal for exterior noise is to achieve Federal Aviation Regulation (FAR) Part 36 Stage 3 noise limits currently required for new subsonic aircraft. The three phases of the concern are as follows: (1) airport noise abatement at communities close to the airport, (2) climb power opening-up procedures, and (3) the climb to cruise phase affecting communities far from the airport.

Author (revised)

N94-33492*# Lockheed Engineering and Sciences Co., Hampton, VA.

ANOPP/VMS HSCT GROUND CONTOUR SYSTEM

JOHN RAWLS, JR. and LOU GLAAB *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1137-1157 Apr. 1992

Avail: CASI HC A03/MF A06

This viewgraph shows the integration of the Visual Motion Simulator with ANOPP. ANOPP is an acronym for the Aircraft Noise Prediction Program. It is a computer code consisting of dedicated noise prediction modules for jet, propeller, and rotor powered aircraft along with flight support and noise propagation modules, all executed under the control of an executive system. The Visual Motion Simulator (VMS) is a ground based motion simulator with six degrees of freedom. The transport-type cockpit is equipped with conventional flight and engine-thrust controls and with flight instrument displays. Control forces on the wheel, column, and rudder pedals are provided by a hydraulic system coupled with an analog computer. The simulator provides variable-feel characteristics of stiffness, damping, coulomb friction, breakout forces, and inertia. The VMS provides a wide range of realistic flight trajectories necessary for computing accurate ground contours. The NASA VMS will be discussed in detail later in this presentation. An equally important part of the system for both ANOPP and VMS is the engine performance. This will also be discussed in the presentation.

Author (revised)

N94-33493*# Lockheed Engineering and Sciences Co., Hampton, VA.

HIGH PERFORMANCE JET-ENGINE FLIGHT TEST DATA BASE FOR HSR

JEFFREY KELLY *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1161-1177 Apr. 1992
Avail: CASI HC A03/MF A06

The primary acoustic priority of the flight test data base for HSR is the validation of the NASA Aircraft Noise Prediction Program (ANOPP) and other source noise codes. Also, the noise measurements are an important support function for the High Lift Program devoted to HSR. Another concern that will be addressed is a possible noise problem 7-20 miles from take-off during climbout. The attention arises from the higher speeds envisioned for the HSCT compared to conventional aircraft causing levels to increase because of Doppler amplification in conjunction with high source levels due to jet noise. An attempt may be made to measure airframe noise for the F-16XL test which would provide an assessment of this noise component for delta wing aircraft.

Author

N94-33494*# Lockheed Engineering and Sciences Co., Hampton, VA.

STATUS AND PLANS FOR THE ANOPP/HSR PREDICTION SYSTEM

SANDRA K. NOLAN *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1181-1196 Apr. 1992

Avail: CASI HC A03/MF A06

ANOPP is a comprehensive prediction system which was developed and validated by NASA. Because ANOPP is a system prediction program, it allows aerospace industry researchers to create trade-off studies with a variety of aircraft noise problems. The extensive validation of ANOPP allows the program results to be used as a benchmark for testing other prediction codes.

Author (revised)

N94-33495*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ATMOSPHERIC EFFECTS ON SONIC BOOM: A PROGRAM REVIEW

GERRY L. MCANINCH *In* its First Annual High-Speed Research Workshop, Part 3 p 1201-1207 Apr. 1992

Avail: CASI HC A02/MF A06

The program goals were determined after consideration of the weaknesses in our understanding of atmospheric effects on sonic boom waveforms left in the wake of the cancellation of the U.S. SST in the 70's and the advancements in acoustics and atmospheric science since that time. For example, a considerable body of knowledge on molecular absorption has built up in the acoustics community over the last 15 years and this has not been incorporated into the sonic boom theory. Further, it was felt that the understanding of atmospheric turbulence had also advanced considerably during that time period. Therefore, key elements of the current program are the development of an improved atmospheric absorption model and an improved atmospheric turbulence model. The advances made in computer power over the last 15 years were also considered, and will be utilized to remove restrictions on the analytical model for turbulence effects on sonic boom waveforms. Although the majority of disturbing sonic booms will not occur at focuses or caustics, it was felt that this was an area that required further understanding, thus it will be looked into. Finally, in order to insure that the current effort, which is basically analytical in nature, retains a firm grasp on reality, a data base of sonic boom waveforms and associated weather data is being compiled, and a set of scale model experiments is being planned to guide the overall efforts.

Author (revised)

N94-33496*# Pennsylvania State Univ., University Park. Graduate Program in Acoustics.

RELAXATION AND TURBULENCE EFFECTS ON SONIC BOOM SIGNATURES

ALLAN D. PIERCE and VICTOR W. SPARROW *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1211-1240 Apr. 1992

Avail: CASI HC A03/MF A06

The rudimentary theory of sonic booms predicts that the pressure signatures received at the ground begin with an abrupt shock, such that the overpressure is nearly abrupt. This discontinuity

ity actually has some structure, and a finite time is required for the waveform to reach its peak value. This portion of the waveform is here termed the rise phase, and it is with this portion that this presentation is primarily concerned. Any time characterizing the duration of the rise phase is loosely called the 'rise time.' Various definitions are used in the literature for this rise time. In the present discussion the rise time can be taken as the time for the waveform to rise from 10 percent of its peak value to 90 percent of its peak value. The available data on sonic booms that appears in the open literature suggests that typical values of shock over-pressure lie in the range of 30 Pa to 200 Pa, typical values of shock duration lie in the range of 150 ms to 250 ms, and typical values of the rise time lie in the range of 1 ms to 5 ms. The understanding of the rise phase of sonic booms is important because the perceived loudness of a shock depends primarily on the structure of the rise phase. A longer rise time typically implies a less loud shock. A primary question is just what physical mechanisms are most important for the determination of the detailed structure of the rise phase.

Author (revised)

**N94-33497*# Wyle Labs., Inc., Arlington, VA.
THE EFFECT OF TURBULENCE AND MOLECULAR
RELAXATION ON SONIC BOOM SIGNATURES**

KENNETH J. PLOTKIN *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1243-1262 Apr. 1992

Avail: CASI HC A03/MF A06

Our objectives are to assess the effect of turbulence and molecular absorption (which is now known to be a key factor in sonic boom shock structure) on shaped sonic booms. Today I will discuss the combination of physical mechanisms for idealized turbulence. In parallel, we are reviewing models for mixed layer turbulence, and these physical effects will eventually be generalized. Author

N94-33498*# Mississippi Univ., University. Physical Acoustics Research Group.

STATISTICAL AND NUMERICAL STUDY OF THE RELATION BETWEEN WEATHER AND SONIC BOOM CHARACTERISTICS
LIXIN YAO, HENRY E. BASS, RICHARD RASPET, and WALTON E. MCBRIDE *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1265-1283 Apr. 1992

Avail: CASI HC A03/MF A06

NASA measured sonic boom characteristics near Edwards Air Force Base from 11/66 to 1/67. Thirty four flights by an F-104 were recorded at an altitude of about 31,000 feet and flying speed of Mach 1.3. Forty two microphones were placed on the ground directly under the flight track. Each microphone recorded boom shape, rise time, peak overpressure, total boom duration, positive duration, and positive impulse. Author (revised)

N94-33500*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SONIC BOOM ACCEPTABILITY STUDIES

KEVIN P. SHEPHERD, BRENDA M. SULLIVAN, JACK D. LEATHERWOOD, and DAVID A. MCCURDY *In* its First Annual High-Speed Research Workshop, Part 3 p 1295-1311 Apr. 1992

Avail: CASI HC A03/MF A06

The determination of the magnitude of sonic boom exposure which would be acceptable to the general population requires, as a starting point, a method to assess and compare individual sonic booms. There is no consensus within the scientific and regulatory communities regarding an appropriate sonic boom assessment metric. Loudness, being a fundamental and well-understood attribute of human hearing was chosen as a means of comparing sonic booms of differing shapes and amplitudes. The figure illustrates the basic steps which yield a calculated value of loudness. Based upon the aircraft configuration and its operating conditions, the sonic boom pressure signature which reaches the ground is calculated. This pressure-time history is transformed to the frequency domain and converted into a one-third octave band spectrum. The essence

of the loudness method is to account for the frequency response and integration characteristics of the auditory system. The result of the calculation procedure is a numerical description (perceived level, dB) which represents the loudness of the sonic boom waveform.

Author (revised)

N94-33501*# Georgia Inst. of Tech., Atlanta, GA.

GEORGIA TECH SONIC BOOM SIMULATOR

KRISH K. AHUJA *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1315-1342 Apr. 1992

Avail: CASI HC A03/MF A06

To examine the building and human response to sonic boom in the range 3 Hz to 30 Hz, Georgia Institute of Technology is building a special acoustic driver system to simulate sonic boom. To support the NASA LaRC program on building and human response, this simulator's capability has been extended to an upper frequency of 4 KHz. A residential test house was made available by Georgia Tech for these tests. At the time of preparation of this document, most of the acoustic drivers and the associated electronics have been built and assembled. The system has, however, not been fully tested. The following pages provide an overview of the progress to date. The acoustic driver systems, and the principle of their operation together with the test house are described. Future plans are also summarized. Author (revised)

N94-33502*# Wyle Labs., Inc., El Segundo, CA.

SONIC BOOM (HUMAN RESPONSE AND ATMOSPHERIC EFFECTS) OUTDOOR-TO-INDOOR RESPONSE TO MINIMIZED SONIC BOOMS

DAVID BROWN and LOUIS C. SUTHERLAND *In* NASA. Langley Research Center, First Annual High-Speed Research Workshop, Part 3 p 1345-1363 Apr. 1992

Avail: CASI HC A03/MF A06

The preferred descriptor to define the spectral content of sonic booms is the Sound Exposure Spectrum Level, LE(f). This descriptor represents the spectral content of the basic noise descriptors used for describing any single event—the Sound Exposure Level, LE. The latter is equal to ten times the logarithms, to the base ten, of the integral, over the duration of the event, of the square of the instantaneous acoustic pressure, divided by the square of the reference pressure, 20 micro-Pa. When applied to the evaluation of community response to sonic booms, it is customary to use the so-called C-Weighted Sound Exposure Level, LCE, for which the frequency content of the instantaneous acoustic pressure is modified by the C-Weighting curve. Author (revised)

N94-33579* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

FLYING ON THE GROUND (Videotape)

1991 Videotape: 11 min. 52 sec. playing time, in color, with sound

(NASA-TM-109825; NONP-VT-94-12953) Avail: CASI VHS A01/BETA A22

This video details research being conducted at LeRC on aircraft acoustics and the impact of aircraft noise on communities and passengers. The video describes LeRC researchers utilization of a laser Doppler velocimeter to study aircraft and the development of the Advanced Ducted Propeller. CASI

N94-33610*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A LABORATORY STUDY OF SUBJECTIVE ANNOYANCE RESPONSE TO SONIC BOOMS AND AIRCRAFT FLYOVERS
JACK D. LEATHERWOOD and BRENDA M. SULLIVAN May 1994

36 p

(Contract RTOP 537-03-21-03)

(NASA-TM-109113; NAS 1.15:109113) Avail: CASI HC A03/MF A01

Three experiments were conducted to determine subjective equivalence of aircraft subsonic flyover noise and sonic booms. Two

of the experiments were conducted in a loudspeaker-driven sonic boom simulator, and the third in a large room containing conventional loudspeakers. The sound generation system of the boom simulator had a frequency response extending to very low frequencies (about 1 Hz) whereas the large room loudspeakers were limited to about 20 Hz. Subjective equivalence between booms and flyovers was quantified in terms of the difference between the noise level of a boom and that of a flyover when the two were judged equally annoying. Noise levels were quantified in terms of the following noise descriptors: Perceived Level (PL), Perceived Noise Level (PNL), C-weighted sound exposure level (SEL_C), and A-weighted sound exposure level (SEL_A). Results from the present study were compared, where possible, to similar results obtained in other studies. Results showed that noise level differences depended upon the descriptor used, specific boom and aircraft noise events being compared and, except for the PNL descriptor, varied between the simulator and large room. Comparison of noise level differences obtained in the present study with those of other studies indicated good agreement across studies only for the PNL and SEL_A descriptors. Comparison of the present results with assessments of community response to high-energy impulsive sounds made by Working Group 84 of the National Research Council's Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) showed good agreement when boom/flyover noise level differences were based on SEL_A. However, noise level differences obtained by CHABA using SEL_A for aircraft flyovers and SEL_C for booms were not in agreement with results obtained in the present study. Author

N94-34303* Georgia Inst. of Tech., Atlanta, GA.
A REVIEW OF AN UPDATED SYNTHESIS OF NOISE/ ANNOYANCE RELATIONSHIPS Final Report
 JAMES M. FIELDS Jul. 1994 92 p
 (Contract NAS1-19061; RTOP 538-03-15-01)
 (NASA-CR-194950; NAS 1.26:194950) Avail: CASI HC A05/MF A01

This report evaluates the evidence supporting the 'dosage-effect relationship for the prevalence of annoyance due to general transportation noise' that was originally presented in 1978 and more recently updated in 1991. The synthesis methods and many of the constituent studies' reports are examined. The weaknesses of the synthesis are identified and found to be partly due to the synthesis methodology, but fundamentally to the lack of comparability in the constituent studies' methodologies and reporting procedures. Several suggested improvements to survey, analysis, and synthesis techniques are proposed. Author (revised)

N94-34380* Harris, Miller, Miller and Hanson, Inc., Lexington, MA.
DOSE-RESPONSE RELATIONSHIPS DERIVED FROM DATA COLLECTED AT GRAND CANYON, HALEAKALA AND HAWAII VOLCANOES NATIONAL PARKS
 GRANT S. ANDERSON, RICHARD D. HORONJEFF, CHRISTOPHER W. MENGE, NICHOLAS P. MILLER, WILLIAM E. ROBERT, CHRISTOPHER ROSSANO, GONZALO SANCHEZ, ROBERT M. BAUMGARTNER, and CARY MCDONALD Oct. 1993 258 p See also PB94-149986
 (Contract NPS-CX-2000-0-0025)
 (PB94-151941; HMMH-290940.14; NPOA-93-6) Avail: CASI HC A12/MF A03

The basic goal of the study was to develop a quantitative relationship between the sound produced by aircraft overflights (the dose) and the reactions of visitors (response) to this sound. The dose-response relationships were developed by measuring sound levels in an area of a park while simultaneously interviewing visitors who had passed through or visited that area. Though many types of dose and response were measured, the analysis and discussions led to selection of two types of dose (aircraft L and percent time aircraft are audible) and two types of response (percent of visitors annoyed and percent of visitors who judged that the sound from aircraft interfered with their appreciation of natural quiet) for development of the final dose-response relationships. These dose re-

sponse relationships may be used to both (1) identify sites that experience impacts from the sound of aircraft overflights and (2) judge the change in impacts likely to result from some alteration in the sound of overflights. NTIS

N94-34393* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTRODUCTION TO GENERALIZED FUNCTIONS WITH APPLICATIONS IN AERODYNAMICS AND AEROACOUSTICS
 F. FARASSAT May 1994 52 p
 (Contract RTOP 535-03-11-02)
 (NASA-TP-3428; L-17300; NAS 1.60:3428) Avail: CASI HC A04/MF A01

Generalized functions have many applications in science and engineering. One useful aspect is that discontinuous functions can be handled as easily as continuous or differentiable functions and provide a powerful tool in formulating and solving many problems of aerodynamics and acoustics. Furthermore, generalized function theory elucidates and unifies many ad hoc mathematical approaches used by engineers and scientists. We define generalized functions as continuous linear functionals on the space of infinitely differentiable functions with compact support, then introduce the concept of generalized differentiation. Generalized differentiation is the most important concept in generalized function theory and the applications we present utilize mainly this concept. First, some results of classical analysis, are derived with the generalized function theory. Other applications of the generalized function theory in aerodynamics discussed here are the derivations of general transport theorems for deriving governing equations of fluid mechanics, the interpretation of the finite part of divergent integrals, the derivation of the Oswatitsch integral equation of transonic flow, and the analysis of velocity field discontinuities as sources of vorticity. Applications in aeroacoustics include the derivation of the Kirchhoff formula for moving surfaces, the noise from moving surfaces, and shock noise source strength based on the Ffowcs Williams-Hawkins equation. Author

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

N94-32428* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A HYPERTEXT SYSTEM THAT LEARNS FROM USER FEEDBACK
 NATHALIE MATHE In NASA, Washington, Technology 2003: The Fourth National Technology Transfer Conference and Exposition, Volume 2 p 55-61 Feb. 1994
 Avail: CASI HC A02/MF A04

Retrieving specific information from large amounts of documentation is not an easy task. It could be facilitated if information relevant in the current problem solving context could be automatically supplied to the user. As a first step towards this goal, we have developed an intelligent hypertext system called CID (Computer Integrated Documentation). Besides providing an hypertext interface for browsing large documents, the CID system automatically acquires and reuses the context in which previous searches were appropriate. This mechanism utilizes on-line user information requirements and relevance feedback either to reinforce current indexing in case of success or to generate new knowledge in case of failure. Thus, the user continually augments and refines the intelligence of the retrieval system. This allows the CID system to provide helpful responses, based on previous usage of the docu-

mentation, and to improve its performance over time. We successfully tested the CID system with users of the Space Station Freedom requirements documents. We are currently extending CID to other application domains (Space Shuttle operations documents, airplane maintenance manuals, and on-line training). We are also exploring the potential commercialization of this technique.

Author (revised)

N94-33401 Kestrel Inst., Palo Alto, CA.

REPORT OF THE WORKSHOPS: AUTOMATED GENERATION OF ELECTRONIC TECHNICAL MANUALS Final Report, Oct. 1992 - Feb. 1993

DAVID L. ZIMMERMAN, CORDELL GREEN, BERT DIMOCK, DAVID R. GUNNING, and GARY WORRALL Dec. 1993 55 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract F33601-93-M-Y842)

(AD-A278046; AL/HR-TP-1993-0036) Avail: CASI HC A04

Paper-based technical manuals are expensive to produce and maintain, difficult to update and modify, and bulky and inflexible in the field. They are fast approaching their practical limit in coping with the complexity of modern Air Force weapons systems. The next 10 to 15 years hold the promise of a revolution, triggered by emerging technologies, in the production and presentation of aircraft maintenance information. This report describes a vision of integrated and electronically based maintenance information support in the future and suggests the specific research and development goals necessary to achieve that vision. The report identifies a number of emerging technologies which will enable maintenance instructions to be created and managed more efficiently, and used more effectively, than they are now. Outlined herein are the essential advancements needed to migrate from a costly and cumbersome world of paper production to the lean world of digital production and delivery. Success in these pursuits will bring enormous benefits both within the economy of human-centered design technology for concurrent engineering and in the performance of maintenance personnel.

DTIC

N94-33581* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE SECOND GIANT LEAP (Videotape)

1991 Videotape: 15 min. 5 sec. playing time, in color, with sound (NASA-TM-109827; NONP-VT-94-12955) Avail: CASI VHS A01/BETA A22

This video describes the purpose and activities of the Office of Space Commercialization at LeRC. The office promotes interactions between industry and NASA researchers, and promotes the benefits of microgravity research. Examples of knowledge transfer in the production of airplanes and farm equipment are shown. CASI

activities; space science; space flight and space technology; space communications; aeronautical activities; studies of the planet earth; and other aeronautical and space activities. Derived from text

N94-33949*# National Aeronautics and Space Administration, Washington, DC.

NASA HISTORICAL DATA BOOK. VOLUME 4: NASA RESOURCES 1969-1978

IHOR Y. GAWDIAK and HELEN FEDOR 1994 441 p NASA History Series

(NASA-SP-4012-VOL-4; NAS 1.21:4012-VOL-4) Avail: CASI HC A03/MF A03

This is Volume 4, NASA Resources 1969-1978, of a series providing a 20-year statistical summary of NASA programs. This series is an important component of NASA published historical reference works, used by NASA personnel, managers, external researchers, and other government agencies. This volume combines statistical data of the component facilities with the data of the parent installation. CASI

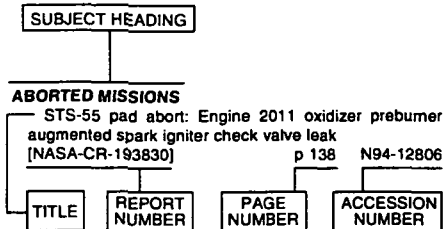
N94-32854# Executive Office of the President, Washington, DC.
AERONAUTICS AND SPACE REPORT OF THE PRESIDENT: FISCAL YEAR 1993 ACTIVITIES 1994

136 p Original contains color illustrations

Avail: CASI HC A07/MF A02

The annual Aeronautics and Space Report includes a comprehensive description of the programmed activities and the accomplishments of all agencies of the United States in the field of aeronautics and space activities during the preceding calendar year. This year's report was prepared on a fiscal year basis, which is consistent with the budgetary period now used in programs of the Federal Government. The following areas are covered: space launch

Typical Subject Index Listing



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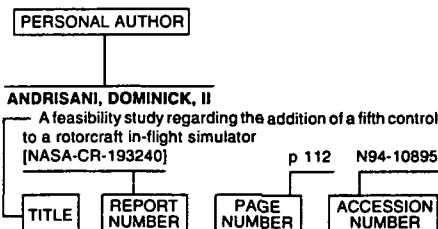
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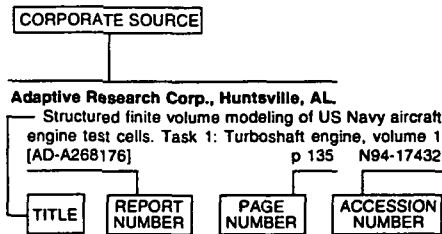
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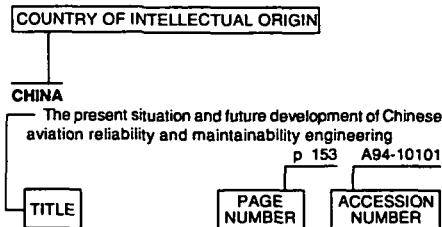
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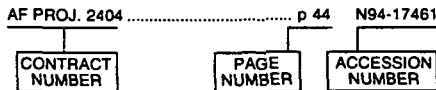
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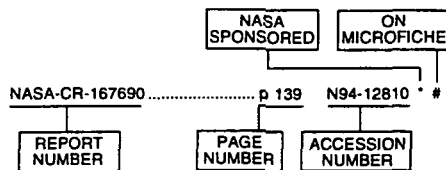
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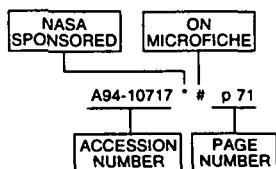
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